THE NEW YOUNG FOLKS' CYCLOPÆDIA OF

GAMES AND SPORTS

BEING VOLUME III OF

CHAMPLIN'S YOUNG FOLKS' CYCLOPÆDIAS, edited by John D. Champlin, Jr., and Arthur Bostwick, 12mo, 831 pp., $2.50.

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THE

YOUNG FOLKS' CYCLOPÆDIA

OF

COMMON THINGS

BY

JOHN DENISON CHAMPLIN

LATE ASSOCIATE EDITOR OF THE AMERICAN CYCLOPÆDIA, EDITOR OF THE CYCLOPÆDIA OF PAINTERS AND PAINTINGS AND CYCLOPÆDIA OF MUSIC AND MUSICIANS, ASSOCIATE EDITOR OF THE STANDARD DICTIONARY, ETC., ETC.

With Numerous Illustrations

SECOND EDITION, REVISED AND ENLARGED

NEW YORK

HENRY HOLT AND COMPANY

1896

PREFACE TO THE FIRST EDITION.

THE Young Folks' Cyclopædia of Common Things has been prepared to fill a vacancy, the existence of which the writer believes no unprejudiced person will deny. Intelligent parents and teachers need not be told that one of the most important habits which can be cultivated in a child is that of consulting works of reference. There are dictionaries and atlases for the use of young folks, but unfortunately all the popular cyclopædias are written in language which a child cannot understand, and no attempt has been made, it is believed, previous to the publication of this work, to bring cyclopædic knowledge within the range of a child's intellect. Yet questions are almost continually arising in the studies, and in the daily experience of youth, which such a cyclopædia would answer without trouble to parents or teachers—to say nothing of numerous questions put by children, which many adults would find a difficulty in answering satisfactorily without reference to books.

In the present work the writer has attempted to furnish in simple language, aided by pictorial illustrations where thought necessary, a knowledge of things in Nature, Science, and the Arts which are apt to awaken a child's curiosity. Such features of Astronomy, Chemistry, Physics, Natural History, and Physiology as can easily be made intelligible are explained, special attention being given to the natural objects which most immediately affect human happiness—such as the phenomena of air, light, heat, and electricity, and those parts of the human system whose health is influenced by our habits. Much attention has been given, too, to the description and explanation of the manufacture of articles in common use, and of the various processes connected with the Arts; while all the animals interesting from their domestic relation or as objects of curiosity have been treated as fully as the limits of the work will permit. If the

writer has seemed in some instances to go beyond the scope of "common things," it is because he has preferred to err on the side of completeness rather than on that of omission. The scheme does not embrace any account of Persons or Places, as they would have added too much to the bulk of a single volume.

The arrangement is the same as in other cyclopædias, as the work is intended to be but a stepping-stone to the more comprehensive ones for adults, and as it is deemed of importance to accustom the child early to the forms and methods which experience has shown to be the best. It has been thought proper, however, to omit all abbreviations, and in most cases to put the scientific classification and etymologies at the end instead of at the beginning of articles, where they will be less likely to destroy the continuity of the narrative, and to blunt the child's interest. While it is not expected that the work will be made a text-book in any of the departments treated in it, it is yet hoped that both pupil and teacher may find it a valuable adjunct to all the more important studies pursued in school, and that it may be thought worthy of a place wherever a knowledge of common things is a necessity.

A large number of works have been consulted and freely used, and the writer, without giving any extended enumeration of authorities, desires to acknowledge his indebtedness to the following ones in particular: The American Cyclopædia; Johnson's Universal Cyclopædia; The Encyclopædia Britannica; Chambers' Encyclopædia; Tomlinson's Cyclopædia of Useful Arts; Ure's Dictionary of Arts, Manufactures, and Mines; Goodholme's Domestic Cyclopædia; The Popular Science Monthly; Harper's Monthly; Scribner's Magazine; St. Nicholas; The Science Primers, edited by Professors Huxley, Roscoe, and Stewart; Holt's Hand-books for Students and General Readers; Packard's Guide to the Study of Insects; Hooker's Child's Book of Nature; and the works of Audubon, Wilson, Baird, Brewer, Agassiz, Storer, Huxley, and Figuier.

J. D. C., Jr.

New York, August 1, 1879.

PREFACE TO THE SECOND EDITION.

THE second edition of the Cyclopædia of Common Things, though made on the same plan as the first edition, is in many respects a new work. All of the original articles have been thoroughly revised and brought down to the present time, such titles as Balloon, Bridge, Cannon, Electricity, Element, Railroad, Rifle, Telegraph, and Telephone having been largely rewritten with many important additions made necessary by the rapid advance in science during the past decade, while enough new articles have been added to fill nearly two hundred extra pages. Among the most important of these new articles are Age, in which is given an account of the mythologic, prehistoric, and historic ages; Architecture, including Cyclopean, Egyptian, Hebrew, Assyrian, Persian, Grecian, Roman, Gothic, Pointed, and Renaissance architecture; Armored Ships, with views of some of the latest war vessels of our new navy; Calendar, with the history of the various divisions of time; Locomotive, telling of its invention and growth; Steamship, with its history from Fulton's first boat to the great vessels that cross the ocean in less than six days; Torpedo, with accounts of the latest devices for the destruction of an enemy's ships; Yacht, with pictures of vessels of the different rigs; and articles illustrating the early history of man on earth—such as Cave, Kitchen-Midding, Lake Dwelling, etc. Numerous smaller articles have been added in the department of natural history, including accounts of many animals, birds, and fishes not described in the first edition, rendering this edition much more comprehensive than that and making it, with its companion-volume, the Cyclopædia of Persons and Places, as complete a cyclopædic compendium as can be given within equal limits. Many new and interesting illustrations too have been added and the whole book has been reprinted from new type.

J. D. C.

NEW YORK, July 1, 1893.


GREECE.
(Naval.)
TURKEY.
(Naval.)
TURKEY.
(Merchant.)
EGYPT.
PERSIA.
JAPAN.
CHINA.
SIAM.
MEXICO.
U. S. OF COLOMBIA.
VENEZUELA.
ECUADOR.
BRAZIL.
ORDEM E PROGRESSO
BOLIVIA.
REPUBLICA BOLIVIA
PERU.
CHILI.
URUGUAY.
ARGENTINE REPUB.


U. S. OF AMERICA.
GREAT BRITAIN. (Naval.)
GREAT BRITAIN. (Merchant.)
FRANCE.
GERMANY. (Naval.)
GERMANY. (Merchant.)
RUSSIA. (Naval.)
RUSSIA. (Merchant.)
AUSTRIA.
ITALY.
SPAIN. (Naval.)
SPAIN. (Merchant.)
PORTUGAL.
NETHERLANDS.
BELGIUM.
DENMARK. (Naval.)
SWEDEN. (Naval.)
SWITZERLAND.

THE

YOUNG FOLKS' CYCLOPÆDIA

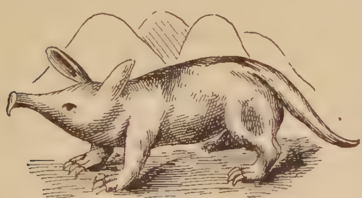
OF

COMMON THINGS.

☞ Words printed in LETTERS LIKE THESE are explained in their alphabetical places.

A

AARD-VARK, an animal common in the hottest parts of Africa, especially in Cape Colony. It looks somewhat like a short-legged hog, but has large flat feet armed with strong claws that enable it to dig deep burrows, in which it lives. When full grown its body, which is generally bare or with only a few



Aard-Vark.

scattered hairs, is between three and four feet long, and its tail about eighteen inches. Its ears are large and pointed, and its head quite long, the upper jaw longer than the lower; its tongue is long, slender, and flat, and is covered with glutinous saliva, which holds fast the ants on which it feeds. It is a timid animal, and when pursued will burrow into the ground so fast as to be out of sight in a few minutes. It comes out at night and roams round looking for ant-hills, the homes of the termite ANT. Though one of these is strong enough to bear a man's weight, the aard-vark easily tears down its walls and licks up the ants by hundreds as they try to escape. The animal thus gets very fat and is much sought for food. Its hams, salted and dried, are very good eating.

The aard-vark is a MAMMAL of the order *edentata*, or toothless animals.

The word aard-vark means earth hog.

ABACUS. See COLUMN.

ACCORDION, a wind musical instrument, played by hand. The Germans call it the *Handharmonika*, because it is made like a mouth-harmonica, only it is blown by means of a bellows inside instead of by the mouth. The left hand works the bellows while the right plays the keys. The accordion has from five to fifty keys, according to size, but it is not worth much as a musical instrument, and is little more than a toy. It was invented in 1829 in Vienna, by a musician named Damian.

The word accordion is from the French *accordeon*, from *accorder*, to accord, to be in harmony.

ACID. In common language acid means sour; but though most acids are sour, there are some which are not, so this definition will not do for all acids. Acids are known to chemists by the way they act on colors got from plants. If a piece of LITMUS paper (paper dyed blue with the juice of a LICHEN called archil) be put into a liquid which has any acid in it, its blue will be changed

to red. If, then, another kind of liquid called an ALKALI be slowly turned into the acid liquid, the red of the litmus paper will fade away little by little, and after a while the blue will come back again. Thus, acids and alkalis are the opposites of each other, for one will neutralize or kill the power of the other.

Acids are found in the juices of plants and in animal bodies and in many mineral substances. We know of several hundreds, and more are being found out all the time. In their common form some are gases, some liquids, and some solids. Acids are generally formed by the union of HYDROGEN, OXYGEN, and some one other ELEMENT which is not a metal. For instance, acetic acid, which makes the sourness in vinegar, and citric acid, which makes the sourness in lemons and limes, are made up of hydrogen, oxygen, and CARBON, united in different parts. Malic acid, found in unripe apples and most acid fruits, such as the gooseberry and currant; tartaric acid, found in grapes and many other plants; oxalic acid, so useful for cleaning brass and copper and for taking ink stains and rust stains out of cloth; and CARBONIC ACID, are other forms of the union of hydrogen, oxygen, and carbon. Carbolic acid, still another form of the union of the same things, smells like smoke. It is valuable as a purifier and for stopping the spread of disease. Carbolic soap is made out of it. NITRIC ACID is made up of hydrogen, oxygen, and NITROGEN, and SULPHURIC ACID of hydrogen, oxygen, and SULPHUR.

Some acids have no oxygen in them. Among these are muriatic or hydrochloric acid, and prussic or hydrocyanic acid. Hydrochloric acid is so called because it is made up of hydrogen and CHLORINE. The pure acid is a gas, the liquid commonly called muriatic acid being the gas mixed with water. A mixture of four parts of muriatic acid with one part of nitric acid is called *aqua regia* (Latin for royal water), because it is the only liquid that will dissolve gold, the king of metals. Muriatic acid is largely used in the arts. Hydrocyanic acid, so called because it is made up of hydrogen and cyanogen (carbon and nitrogen), smells like bitter almonds and is a deadly poison. It is found in small quantities in bitter almonds, in the kernels of peaches and of plums, and in peach leaves, giving them their peculiar taste. These things are sometimes used to flavor food with, there not being enough of the acid in them to do any harm. Common prussic acid, which is so called because it was first made from Prussian blue, is hydrocyanic acid mixed with water.

Acids have many different powers and uses. While some are healthful and are used for food, others are deadly poisons when breathed into the lungs or taken into the stomach; and while some are harmless to touch others are very biting. Sulphuric acid will char and destroy most vegetable and animal substances, and nitric acid will make yellow stains and wounds where it touches the skin. In the article BASE is told how the mixture of an acid and a base makes a SALT.

The word acid is made from the Latin *acidus*, sour or sharp to the taste, which comes from *acus*, a needle.

ACORN, the seed or fruit of the oak tree. Most kinds of acorns contain STARCH and OIL, and have a bitter taste; but some are not bitter, and are largely used as food in Spain, Algeria, and other Mediterranean countries, being liked better than chestnuts. In California the Indians pound up acorns in a mortar and make cake and mush out of the meal. The cup of one kind of acorn is made into a fine black dye, and is used also, like bark, for tanning leather.

The word acorn is from the Anglo-

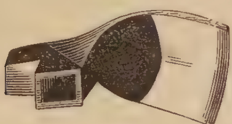
Saxon *æcer*, a field, and means the fruit of the field.

ACRE, a measure of land in England and the United States. It contains 4840 square yards or 43,560 square feet, whatever may be its shape. If in a square it would measure nearly 209 feet on each side; so that an acre is equal to about seventeen city lots, each 25 by 100 feet. The acre was originally as much as a yoke of oxen could plough in a day, but in the thirteenth century it was made by law of its present size.

The word acre is from the Latin *ager*, a cultivated field.

ADZ, a tool for smoothing timber, much used by ship carpenters. It has a handle like an ax, but the blade, which is made like a broad chisel, has the cutting edge crosswise instead of in a line with the handle.

The adz is used also by house-carpenters in squaring timbers for the frames of buildings. The head of the common adz is shown in the



Adz.

picture. Another kind of adz, used in making wooden spouts and other hollow work, has the edge hollowed out like a gouge. A coopers' adz is much like the common adz, but has short handle, and is used in one hand like a hatchet.

The word adz is the modern form of the old English *addice*, which came from the Anglo-Saxon *adese*.

ÆOLIAN HARP, a box with strings stretched tightly across it, which make music when the wind blows on them. The box, which is of very thin boards, is about five inches deep and six or eight inches wide, and usually just long enough to fit across a window. The strings, which may be of twisted silk, catgut, or wire, are stretched across the top of the box from end to end, and tuned together. When the harp is placed on the window-sill and the window is raised just high enough to let the wind blow across the strings, it makes a sweet but sad kind of music.

The Æolian harp is named from Æolus, the ancient Greek god of the winds.

AËROLITE, a mineral body that has fallen to the earth from some place outside of the earth. When seen as globes of fire or as shooting stars in the air, aërolites are commonly called meteors; though any natural occurrence in the air, such as rain, snow, hail, rainbow, lightning, aurora borealis, etc., is properly a meteor; hence the term meteorology (Greek *meteoros*, lofty, and *logos*, discourse) means the description of things that take place in the air. For a long time it was not known whence aërolites came. Some thought they were formed in the upper parts of the earth's atmosphere by the hardening of the gases of solids, just as hailstones are formed by the freezing of watery vapors; others, even up to the early part of this century, believed that they were thrown from volcanoes in the moon. It is now known that there are numberless bodies moving through space of which we know little, most of them being too small to be seen even by the most powerful telescopes. Kepler, the astronomer, says they are more numerous than the fishes in the ocean. When the earth, in its annual course around the sun, meets any of these bodies, called meteoroids, some come near enough to be acted on by gravitation (see EARTH) and to be drawn to its surface. In passing through the air they become so hot that some are burned up or turned to gas, and some are so hard and solid that they give out a brilliant light and are seen as meteors or shooting stars. Only a small part reach the earth as aërolites. These sometimes fall in a large mass and

sometimes broken into pieces, so as to make a shower. They generally come with such force as to bury themselves deep in the earth. A monk was once struck by an aërolite and instantly killed, and it is thought that vessels at sea may have been sunk by them.

An aërolite weighing 1635 pounds, which fell in Texas in 1808, is now in the Peabody Museum, Yale University. One in the Smithsonian Institution, Washington, which fell in Mexico about 1500, weighs 1400 pounds. The largest known were found on the west coast of Greenland, one of which, in the Stockholm Royal Academy, weighs 25 tons, and another, in the Copenhagen Museum, 10 tons. One weighing more than five tons is in the British Museum. Aërolites are made up of the same things that are found on the earth, about one-third of the ELEMENTS having been found in them; but they are combined in a different way so that it is easy to tell them. Thus, they are generally made up largely of iron, but mixed with nickel in a way never found on earth.

Aërolite means "air stone," from Greek *aër*, air, and *lithos*, stone.

AGATE, a kind of QUARTZ, marked with many colors in clouds, spots, or layers. Agates are found in loose rounded pieces inside of rocks, or as loose pebbles in beds of rivers or gravel. They vary usually from the size of a filbert to that of a small apple, but some have been found larger than a man's head. Agates are made up mostly of silica (see SILICON), and the colors come from particles of iron mixed with it in different ways. When polished they show many wonderful forms, in some the colors being in layers, in some in zigzag lines, while in others they look like animals, trees, moss, leaves, and other natural objects. Quantities of moss agates are found in Colorado, Utah, Wyoming, and Montana, some of which are very beautiful. In the British Museum is a remarkable agate from Egypt which shows on both sides a likeness of the poet Chaucer.

As agates take a fine polish, they are much valued as ornamental stones. Most of the agates sold are brought from Oberstein and Idar, small towns on the river Nahe, near Mainz, Germany, where many of the inhabitants are employed in cutting and polishing them. The rough agate stones are brought there chiefly from Uruguay and Brazil. They are first ground on large millstones turned by water wheels in small mills along the banks of the Nahe, and afterward polished on wheels of soft wood covered with powdered ROTTEN STONE. Scotch pebbles, common in Scotland, where they are cut and polished, are a kind of agate. Agates are much used in the manufacture of rings, seals, beads, handles for knives and forks, sword hilts, cups, smelling bottles, and many other ornamental things. Burnishers for polishing, used by bookbinders and other mechanics, are also made of agate.

Agates are found in many parts of the United States, especially at Agate Bay, Lake Superior, and in Colorado, but the agates cut in Germany are sold so cheap that it does not pay to cut them. In Apache County, Arizona, is a wonderful petrified forest, called Chalcedony Park, where the ground is covered with immense tree trunks turned to agate, jasper, and chalcedony. In one place an agatized tree three to four feet thick and more than a hundred feet long, has fallen across a cañon about fifty feet wide, so as to form a natural bridge over it. Agatized wood is found also in Utah, New Mexico, and California. It is used for mantles, table tops, tiles, and even for columns in fine houses; also for clock cases, cane and umbrella handles, paper weights, and toilet articles.

The word agate is from the Latin *achates*, and the stone was so named

because it was first found near the river Achates in Sicily.

There are several other stones much like the agate, some of which differ from it only in their coloring matter. The principal ones are:

Bloodstone, a green agate marked with red spots like blood. It is sometimes called Oriental jasper.

Carnelian, which is found in different shades of red and yellow. The most valuable kind is the deep red. The best carnelians come from Japan and from India. The word carnelian is from the Latin *caro*, genitive *carnis*, flesh, some of the commonest ones being flesh color.

Chalcedony, or calcedony, of a milk white or whitish yellow; sometimes found in such large pieces that cups and other vessels are made of it. It is brought from Iceland, Cornwall, in England, and Nova Scotia. Chalcedony got its name from the ancient city of Chalcedon, in Asia Minor, where much was found.

Onyx, usually found in layers of white and brown, dark red, or black. Many cameos are cut in onyx, the raised figure being in the white, and the dark layer making the background; but sometimes the raised figure is cut in the dark layer, and the background made of the white. See MEXICAN ONYX.

Sardonyx, a beautiful and valuable kind of onyx, marked with layers of white and a rich orange brown.

Onyx is named from the Greek *onux*, a finger nail, because the colors are in flat layers, like the marks in the human nails. Sardonyx is named from Sardis, in Asia Minor, or, as some think from Sardo, the Greek name of Sardinia.

AGAVE, the name of a family of plants growing wild in Mexico, Central America, and the hot parts of South America. They are called also American aloes, though they are not aloes, and in Spanish America *maguey* or *mezcal*. These plants are now cultivated in gardens in Africa, Western Asia, India, and in Southern Europe, but in England and the cool parts of the United States they have to be grown in greenhouses. The principal kind of agave, commonly called the century plant, because it was formerly thought to bloom but once in a hundred years, often blossoms in warm countries when less than ten years old, though in cool climates it may not flower before it is forty or fifty years old. The flower stem grows very fast, sometimes six inches a day, until it is twenty to

The Agave.

forty feet high, and bears numerous branches, each with a cluster of greenish-yellow flowers, which remain several months. As soon as they fall the plant dies to the ground, and the roots then send up new shoots. In Mexico the agave is considered one of the most valuable of plants. When the flowering bud forms it is cut out, and the sap, which would have gone to feed the stalk, collects in the hollow. This is dipped out daily and let stand awhile, when it ferments and makes the drink called *pulque*, from which the Mexicans distil (see ALCOHOL) a stronger liquor called *vino mezcal*,

mezcal wine. Both this and other kinds of agave furnish from their leaves a strong thread called pita flax, which is made into twine, ropes, mats, nets, and hammocks.

The dry stems too make good razor strops, on account of the silica (see SILICON) in them, and a kind of soap is made from the leaves.

The word agave is in Greek *agave*, which is from *agavos*, illustrious or noble.

AGE, a period or era in the life of the world or in the history of the human race. The ages of the world, or geologic ages, are told about under EARTH. The ages mentioned by the classic poets are called the mythologic ages because they are fabulous; those relating to the history of man before records were kept, the archæologic ages, and those relating to the history of man since records began to be kept the historic ages.

Mythologic Ages. The Greek poet Hesiod, in his "Works and Days," divides the history of mankind into five ages, during each of which the earth was peopled by a different race of men: the Golden Age, when man lived on the fruits of the earth without labor or pain, and passed away in a gentle sleep; the Silver Age, a lawless time when man refused to worship the gods, and was buried by Jupiter in the earth; the Bronze Age, when man was warlike and cruel and perished by violence; the Heroic Age, composed of the heroes who fought at Troy and Thebes, who were rewarded after death by being permitted to reap thrice a year the free produce of the earth; the Iron Age, the worst of all, when justice and piety had gone from earth and man was sunk in vice. The Roman poet Ovid tells of four ages only, leaving out the heroic age.

Archæologic Ages. The history of MAN is divided commonly into three ages: the Stone Age, when the use of metals was unknown and weapons and tools were made out of stone; the Bronze Age, when implements were made out of a kind of bronze; and the Iron Age, when men had found out how to melt and work iron. It is not known how long men existed in either of these ages, nor is it possible to give an exact limit to any of them, as they lap over into each other in many places. Some writers speak of the present as the age of steam, and of the coming age as the age of electricity.

Historic Ages. The time between the fifth century, when the barbarians overran the Roman Empire, and the beginning of the fifteenth century, when learning began to revive in Europe, is called the Dark Ages. The term Middle Ages is given to nearly the same period, the ten centuries between the fall of the Western Empires in 476 to the discovery of America in 1492; or, as others divide it, from the division of the Roman Empire into the Eastern and Western Empires in 395 to the capture of Constantinople by the Turks in 1453. The period between 1096 and 1291, during which the Christians of Europe tried to recover the Holy Land from the Saracens, is called the Age of the Crusades. Other ages frequently mentioned in books are the Periclean Age or Age of Pericles, when literature and the arts flourished in Greece; and the Augustan Age, or reign of the Emperor Augustus, the period when Cicero, Horace, Ovid, Virgil, Catullus, Tibullus, and other writers of the purest Latin lived. The time when Addison, Steele, Swift, Defoe, and others wrote, about the reign of Queen Anne, is sometimes called the Augustan Age of English literature; and the latter part of the reign of Louis XIV., the Augustan Age (*siècle d'Auguste*) of French literature. The reign of Queen Elizabeth in England is known as the Elizabethan Age, and that of Queen Victoria as the Victorian Age.

AIR. We cannot see air, but we know that it is all around us, for

we take it into our lungs with every breath. When it moves we call it wind, and we can then see and feel what it does; but air is in the stillest places as well as where the wind blows the hardest.

Air is a gas (see ELEMENT) without taste or smell, and in small quantities it is without color: but when we look up into the heavens in a clear day, it appears bluish. It is not a single gas by itself, but a mixture of several gases, the chief of which are NITROGEN and OXYGEN. In every five gallons of air there are nearly four gallons of nitrogen and one gallon of oxygen; and, fortunately for us, this amount is always the same. If the air were all nitrogen, we should die for want of oxygen; and, if it were all oxygen, we should live so fast that our lives would soon be spent, and everything that can burn would quickly burn up. But just enough parts of each are mixed together in the air to make it safe and healthful to breathe.

The air has in it also, besides oxygen and nitrogen, a small portion of another gas called CARBONIC ACID. This gas is deadly if breathed into the lungs by itself, but it is safe when mixed, as it is in the air, with oxygen and nitrogen. It has too an important use. Every breath of air taken into the LUNGS becomes changed, that which we breathe out having less oxygen and more carbonic acid in it than that which we breathe in. The nitrogen is not changed; just as much of that is breathed out as is breathed in. A full-grown man breathes out every day more than two pounds of carbonic acid. As animals, as well as human beings, are all the time using up oxygen and breathing out carbonic acid, there would soon be so little oxygen and so much carbonic acid in the air as to make it poisonous, if there was not some way of getting more oxygen and of using up the carbonic acid. This is done by the leaves of all growing plants, which, with the aid of the sunshine, are always taking in carbonic acid and giving out oxygen. The carbonic acid thus taken in gives the CARBON for the growth of the PLANT, and the oxygen that comes from the leaves mixes with the nitrogen of the air and becomes fit to be breathed by animals again. Thus the oxygen and the carbonic acid in the air are always changing, and animals and plants are helps to each other.

The air of cities is less pure than that of the country because there are more people to breathe it and use up its oxygen, and fewer plants and trees to take in the carbonic acid gas and give back the oxygen. It is also made impure by gases from sewers, drains, and filth, and by close streets and alleys, which prevent the blowing in of fresh air.

Water too has mixed in it a good deal of air, or FISHES could not live. They also breathe in oxygen and breathe out carbonic acid, and the carbonic acid is used up and oxygen is given out by sea plants just as is done by plants and trees on land. If there were no plants in water, the carbonic acid would increase so as to kill all fishes and other animals living in it.

Besides these three gases air always has watery vapor in it. This is going up from the earth all the time, not only from seas, lakes, rivers, and damp places, but also from the leaves of plants and the lungs and skins of animals. Even in the pleasantest weather, when the sky looks clear and blue, there is watery vapor in the air. We cannot see it then because it is divided into very small particles, but it often changes and turns into CLOUDS or FOG, or falls as RAIN, and then we see it.

Air may be weighed like lead, stone, or any other substance. If a tight vessel full of air be weighed, and then weighed again after the air has been pumped out (see AIR-PUMP), it will weigh less the

second time than the first. Air may be compressed or packed closely into a smaller space than it usually fills. If you push a tumbler down, bottom upward, into a bowl of water, the water will rise up inside of the tumbler and press the air into a smaller space. It is the same in the DIVING BELL. When it is sunk in very deep water, the air becomes so dense or thick that a man can hardly live in it. Divers have sometimes been killed in this way. Air is also elastic—that is, it will go back into its former shape when the pressure is taken off from it. This also is shown by the diving bell. The air, closely packed in it, swells as the bell is drawn up, and forces the water out, until, at last, when the bell leaves the water, it becomes of the same thickness as the surrounding air. These qualities of air—compressibility and elasticity—make it capable of driving machines, and it is now much used in motors. In Birmingham, England, air is compressed by means of steam engines until the pressure is forty-five times as great as the atmosphere, and delivered in pipes like gas-pipes to workshops and houses to be used in driving machines from half a horse-power up to fifty horse-power. It is used also for driving dynamos for electric lighting, and even for driving tram or street cars. In Paris compressed air is supplied to hotels and houses through pipes for running elevators.

The common air which we breathe will also swell when the pressure is taken off from it. If a bladder filled with air be placed in a tight jar and the air around it in the jar be then pumped out, the air in the bladder will swell and burst it. Air is also impenetrable, by which we mean that it will keep out all other matter from the space where it is. A very simple experiment will prove this. Fit a funnel tightly into the neck of an empty bottle, so that no air can get in at the side. You may then fill the funnel full of water and it will not run into the bottle, because the air within is impenetrable.

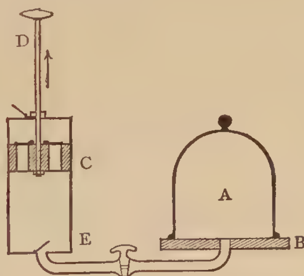
When we say that the air has weight we mean that it is attracted or drawn by the earth just as all other things are. Being also compressible, the lower part of it, which rests on the earth, is pressed down by the great weight of the air above it, so that it is much thicker than the upper air. This pressure is so great that one-half of the whole atmosphere is squeezed into a belt around the earth about two and three-fourths miles high; while the other half, which is free from this pressure, is so spread out that it reaches to a height of more than forty miles. Some believe that very thin air extends still further, but the entire height of the atmosphere is generally thought to be about forty-five miles. The pressure on the earth at the level of the sea is about fifteen pounds to each square inch of surface. A man of common size thus bears all the time a weight of about 30,000 pounds of air, which is equal to fifteen cartloads of coal. This would crush him if the air did not press in every direction, not only downward, but upward and sidewise as well; and if the body were not filled with air and other fluids of the same thickness as the surrounding air, which press equally outward. If the pressure of the outer air were taken off, the fluids within the body would swell, and the parts in which they are held would burst. Persons who go up in balloons often feel great pain, because the upper air is much thinner than that below, and the air and other fluids within them being partly freed from the outward pressure expand and force themselves through the pores of the body, especially out through the thin skin inside the nose and mouth. The pressure of the air is well shown by the leather toy called a "sucker." When this is wet and placed upon a smooth surface so as to keep out the

air between, the weight of the atmosphere pressing on the upper side causes the leather disc to stick so firmly that a brick or stone may easily be raised by it. It may be shown in another way with a glass tube, one end of which is under water. If the air be sucked out of the tube, the water will rise in it to a height equal to the pressure of the air on the surface of the water outside the tube (see BAROMETER). The common suction PUMP works in this way.

Air is also swelled by heat and shrunken by cold. If a bladder filled with air be heated, the air will swell and burst the bladder. The atmosphere gets but little HEAT directly from the sun; generally, the sun heats the earth, and the earth heats the air. As it grows warm it becomes thinner and rises, giving place to colder air, which in turn becomes heated and rises until the entire atmosphere is heated. Air is also condensed and made heavier by cold. If a bladder filled with air be put in the cold, the air in it will shrink and the bladder will become flabby. The continual heating and cooling of the air by heat and cold cause the waves of air which we call WIND.

The word air comes from the Greek *aer*, which means the same thing.

AIR-PUMP, a pump for drawing the air out of a close vessel. In the picture, A is a glass vessel called a bell-glass, which is open at the bottom, but is made to fit tightly on to the brass plate B. The cylinder or barrel C, has a piston D, which moves up and down in it, but fits so closely that no air can get by it. The bottom of the cylinder is joined with the bell-glass by the tube E, which goes through the plate B. At the bottom of the cylinder is a little VALVE or kind of trap door, which opens only upward, and in the piston is another opening the same way. Now, suppose that the piston is at the bottom of the cylinder and the two valves are closed. If the piston be pulled up, an empty space will be left in the cylinder into which the air from all sides will try to rush. The air above the piston cannot get in, because the valve does not open downward; but the air from the bell-glass will push open the lower valve and fill the space. If the piston be now pushed down, the air under the piston will press down and close the lower valve, but will at the same time open the upper valve and go out into the outer air. But this air, which was in the cylinder under the piston, was a part of that in the bell-glass; and every time that we thus work



Air-Pump.

the piston we draw out a little more of the air from it, so that in time we get it nearly all out. Some air-pumps work in a different way, but the principle is the same in all.

The space thus made is called a vacuum (Latin, *vacuum*, empty space). We cannot make a perfect vacuum with an air-pump, for a little air will always stay in the bell-glass. Many curious things may be shown with an air-pump; in a vacuum made by it a candle will go out, because there is no OXYGEN to feed its flame; smoke will fall down like lead, because there is no air to keep it up, and an animal will quickly die for want of oxygen. The air-pump is used in the low-pressure STEAM ENGINE, and also in many manufactures, such as condensing MILK, refining SUGAR, etc.

ALABASTER, a fine-grained, whitish limestone. There are two kinds: gypsum alabaster, a sulphate of lime, which is the more delicate and soft, and calcareous alabaster, a carbonate of lime, which is firmer in grain. Gypsum alabaster, which is largely used in the manufacture of vases, statuettes, clocks, frames, boxes, and other small ornaments, is found in Italy, France, and in several parts of England. Florence is the chief centre of the alabaster trade. A yellow kind, found near Siena, Italy, is called *alabastra agatato*, agatized alabaster. When alabaster is fibrous like threads, it is called "satin spar." Calcareous or Oriental alabaster is entirely different from gypsum alabaster, and is made by the dripping of lime water, like stalagmites in caves. Ancient quarries, near Thebes, worked by the Egyptians, are still unexhausted. This alabaster is sometimes marked like agate and is then called onyx marble. A quarry near Oran, Algeria, is of this kind, and the stone is called Algerian onyx. See MEXICAN ONYX.

The word alabaster is said to be from the Arabic *al batstraton*, the whitish stone. Others say it is from the Greek *alabastron*, a perfume pot or vase, made at Alabastron, in ancient Egypt.

ALBATROSS. See GULL.

ALBINO, a person or animal whose skin and hair are whiter than is usual, from the want of coloring matter in them. It is supposed to be caused by a disease. The name was first given by the Portuguese to the white negroes on the coast of Africa, but it is now applied to persons of any race who are whiter than they ought to be. Albinos are more common among dark-skinned than among yellow and white races. The skin and hair of the human albino are of a dull milky white, and some parts of the eye are deep red. The eyes are weak in the day-time, but albinos can see better at night than other persons. There are albinos among animals, birds, and insects; the white ELEPHANT, white mouse, white crow, and white blackbird are examples.

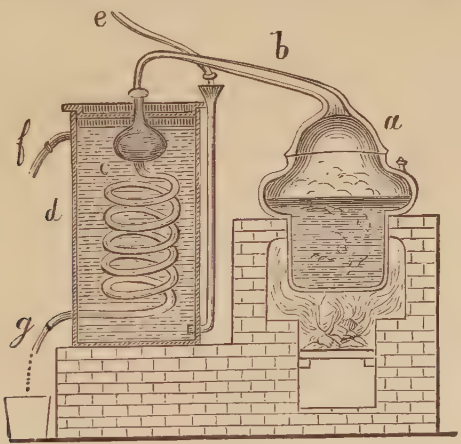
The word albino comes from the Latin *albus*, white.

ALBUMEN. A boiled egg is made up of two kinds of meat: the yolk, which is yellow, and a pure white substance which lies around it. The white is albumen, hardened and made white by heat. When raw it is thin and almost colorless, like gum. The yolk of the egg is also albumen, but mixed with a yellow oil which colors it. Albumen is found in the blood and the flesh of all living beings. The more there is in meat, the more tender it is. The flesh of young animals is more tender than that of old animals because it contains more albumen; and it becomes spoiled quicker for the same reason. Salted meat is not so good for food as fresh meat because the albumen is taken out of it by the brine. Meat boiled too long becomes tough because the albumen is hardened like the white of a hard-boiled egg. Albumen abounds also in the juices, grains, and other parts of plants. It is the most important part of food because it contains in a small space more that is good and easily digested than any other kind of food. For this reason eggs, which have so much of it in them, are the strongest of all foods. Albumen is the principal one of a class of substances called the albuminoid or nitrogenous substances, which, like the starchy and fatty substances, is made up of CARBON, HYDROGEN, and OXYGEN, but unlike them has also NITROGEN in it. (See FOOD.)

The word albumen is Latin, and is made from *albus*, white; the substance is so called because the white of egg is almost pure albumen.

ALCOHOL, the spirit in wine, beer, cider, etc. When the juice of apples is first pressed out, it is sweet and has none of the sharp taste of cider; and it does not become cider until

it has fermented (see YEAST) or worked, which takes place after it has stood a while. Apple juice is only sugar and water flavored with the taste of the apple, but after it has worked its sweet taste is gone, and it has spirit or alcohol in it. This comes from a change caused by the working. Neither the water nor that which makes the flavor is changed, but only the sugar, which has become alcohol. It is the same in making wine. Grape juice is only sugar and water flavored with the taste of the grape; but, by fermentation, the sugar is turned into alcohol, and the grape juice becomes wine. Now sugar and alcohol are made up of just the same things—CARBON, OXYGEN, and HYDROGEN—only the parts are different. When the apple or grape juice ferments, bubbles of CARBONIC ACID are given off. Thus some of the carbon and some of the oxygen of the sugar escape into the air; the hydrogen remains just the same, and, with the carbon and oxygen which are left, forms alcohol. Therefore, sugar, by fermentation, is divided into two



A Still.

things, carbonic acid gas, which goes off into the air, and alcohol, which stays behind in the liquid.

All spirituous liquors have alcohol in them, and it is this which makes people drunk when they drink too much. Brandy, whiskey, rum, and gin, which are called distilled liquors, are about one-half alcohol; sherry and port wines about one-fourth or one-fifth, and claret and white wines one-tenth. Ale and cider have still less in them. Distilled liquors are so called because they are made by distillation (from Latin *destillare*, to trickle or drop down). The substance to be distilled is first heated until it turns to vapor or steam; this vapor then passes into another vessel which is kept cold, and the coolness condenses it (from Latin *condensare*, to make thick), that is, turns it back into a liquid. Now alcohol will boil and turn into vapor at a much lower heat than water; therefore the alcohol vapor will all pass over into the condenser or second vessel, and be condensed into a liquid again before the water begins to boil much.

The process is shown in the picture, where *a* is a large copper vessel called a still, in which the substance to be distilled is heated over a furnace fire. The vapor of the alcohol

rises, passes through the pipe *b* down into the condenser, which is made up of a coiled tube *c* (called from its looks the worm) in a vessel *d*, called the worm-tub. The worm-tub is kept full of cold water by means of the pipe *e*. The water enters the tub near the bottom and runs off through the pipe *f* at the top, so that it is always cool; and the vapor of the alcohol passing through the worm is cooled and condensed and trickles out of the end of the pipe at *g*. Some watery vapor, or steam, will always pass over and be condensed with alcohol, so that distilled liquors are usually about half alcohol and half water; but by distilling several times the alcohol may be got nearly pure.

Alcohol is much used in medicine and in the arts. Medicines are made by mixing drugs with it, cologne and other perfumed spirits by flavoring it with different kinds of oils, and varnishes by putting into it resins and gums. When mixed with spirits of turpentine, it makes camphene and burning fluid. Alcohol will not freeze, and therefore it is used in very cold countries in THERMOMETERS instead of mercury. It has a great liking for water, and mixes with it readily. Meat put into it will keep for a long time, for the alcohol takes the water out of it, and thus keeps it from decaying. For this reason it is much used by doctors and others to preserve specimens in. Alcohol is burned in lamps when a very hot flame without smoke is wanted, and in Germany it is much used in little cooking stoves.

Alcohol gets its name from the Arabic *al kohol*, the powder of antimony, with which people in Asia stain their eyelids. This powder is very fine and pure, and the name was in time given in Europe to alcohol, because it is a pure extract; but the Arabs never used the word in that way.

ALDER, a common tree, which grows usually in wet land. The principal kinds of it belong to North America. Alder wood is valuable for turning and for some kinds of cabinet work, and it is also used for mill-wheels and other wood-work under water. Its CHARCOAL is considered the best for making gunpowder, and its bark is used in tanning leather and in dyeing cloth black and yellowish-brown.

The word alder is from the Anglo-Saxon *aler*.

ALE. See BEER.

ALEWIFE, a fish of the herring family, but larger than the herring. It differs too from the herring, which is a sea fish only, in going up rivers and brooks into ponds and lakes. Alewives appear soon after shad, and are caught in all the rivers of the north Atlantic coast in the same way with that fish; but they are much more abundant than shad, being caught often by the million. They are so plentiful that many other kinds of fish live on their young, which too are excellent bait for cod and mackerel. The alewife is an excellent food fish, being nearer to the shad than the herring.

The word alewife is from *aloof*, the Indian name of this fish.

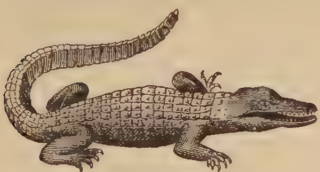
ALKALI, the common name of a class of BASES which differ in some things from other bases. They have a peculiar sharp and biting taste. In the article ACID is told that if a piece of blue litmus paper be put into an acid, the paper will turn red. If now the same piece of paper, reddened by the acid, be put into an alkali, it will turn blue again. Thus the action of the acid is neutralized or killed by that of the alkali. If an alkali be mixed with an acid, the two will unite, like any other base with an acid, and form a SALT. Alkalies unite with oils and fats to form SOAP. The principal alkalies are SODA, POTASH, and AMMONIA.

Some other substances also, such as lime and magnesia, have the power of neutralizing acids, and are

therefore called alkaline earths; but in other things they are not altogether like alkalies.

The word alkali is from the Arabic *al kali*, the ashes of a plant from which soda was once made.

ALLIGATOR, a large reptile, found only in North and South America. It lives both on the land and in the water. It looks like the crocodile, but differs from it. The crocodile lives either in salt or in fresh water, but the alligator never goes into the salt water. The common alligator found in the Southern States grows 14 to 15 feet long; its head is about one-seventh of its entire length, and its mouth is very large, with a single row of pointed teeth in each jaw. Fish is its principal food, but it catches and



Alligator.

devours land animals and sometimes even men. It likes a negro better than a white man, and a dog or a hog better than either. It lays 50 to 60 eggs, about the size of goose eggs, covers them with sand, and leaves them to be hatched by the sun. The young, which are five or six inches long when they leave the shell, take to the water as soon as hatched. They love to play in the sunshine, and when frightened will scamper away yelping like puppies. When there is any danger the mother alligator will sometimes swallow her young, who run one by one down her throat. The hide of the full-grown alligator is covered with bony scales, which are very hard, but it is not true that a rifle-ball will not go through them, as is generally said. A rifle-ball will go into an alligator almost anywhere, if it strikes fairly. Alligator skin, when tanned, makes good leather for boots and shoes.

The alligator is a REPTILE of the crocodile order.

The word alligator is from the Spanish *el lagarto*, the lizard, a name given to this reptile by the Spaniards because they thought it looked like a lizard.

ALLOY. Pure gold and silver are quite soft and would be easily worn out by use. They are not fit therefore to make coins of until they have been mixed with some metal to harden them. This is called alloying, and the mixed metal itself is called an alloy. Alloys are made with different kinds of metal; for instance, BRONZE, BRASS, PEWTER, and TYPE METAL, are all alloys. The silver coins of the United States are made up of nine parts of silver and one of copper; in the gold coins nine parts are gold and the other part is one-quarter silver and three-quarters copper. A mixture of MERCURY or quicksilver with another metal is called an AMALGAM.

The word alloy is from the French *aloyer*, Latin *alligare*, to combine.

ALLSPICE, the berry of the pimento tree, a small bushy tree of the myrtle family. It is so called because it is supposed to unite the flavor of cloves, nutmegs, and cinnamon. The pimento grows in South America and the West India Islands, particularly in Jamaica. It is an evergreen, and is sometimes four or five times as high as a man. The berries, which are about as large as currants, are picked when full grown, but before they begin to ripen, and are carefully dried. Allspice is sometimes called Jamaica pepper. It is used for flavoring food, and an oil is distilled from it. In Jamaica the berries are sometimes smoked instead of tobacco.

ALMANAC, a book telling the division of the year into months, weeks, and days, the time of the rising of the sun, the moon, and the

tides, and other useful things. The Arabs are supposed to have first made them. The first printed almanac was a German one, published in Vienna in 1457. Most of the early almanacs pretended to foretell the weather and other events, and some almanacs still do so; but they are believed only by ignorant persons. Almanacs giving information about official matters and other facts are now published in almost all countries. One of the most celebrated of these, the *Almanach de Gotha* (Almanac of Gotha), published at Gotha, in Germany, in both French and German, has been printed yearly since 1763. More than 100 almanacs of all kinds are published in the United States.

It is not certainly known what this word is made from. Some think it is an Arabic word, and others that it comes from the Anglo-Saxon *all-monaght*, a sketch or drawing of the course of the moon.

ALMOND, the fruit of the almond tree, which grew first in Western Asia and in the countries around the Mediterranean. The tree is seldom more than fifteen feet high, but when grafted on the plum it reaches twenty or thirty feet. Its wood, which is hard and reddish, is used for veneering. Its fruit or nut is covered with a hard green shell which dries as it ripens, and finally bursts open, and lets the almond drop out. There are two principal kinds of almonds, the sweet and the bitter. Sweet almonds are largely used in confectionery and for dessert, but they are not worth much for food, and are very hard to digest. Almond oil, made by pressing almonds, is used as a flavor in medicines, and for scenting toilet soap. The bitter almond is smaller than the sweet, and has in it less oil; and the oil is very poisonous, owing to prussic acid in it. Almonds are brought from France, Spain, Italy, Malta, and the East. Jordan almonds are brought from Malaga. Very fine almonds are now raised in California, and it is thought that they will soon drive foreign kinds out of the market. Three kinds are brought from there, called paper-shells, soft-shells, and hard-shells. Paper-shells, which have very thin shells, sell for about twice as much as soft-shells; hard-shells are sold only for the drug trade. There is also a false paper-shell that has two thin shells; the true paper-shell has but one thin shell next to the fruit.

The almond tree belongs to the same family with the PEACH, PLUM, CHERRY, and NECTARINE.

The word almond has been changed from its Latin name *amygdala*, from the Greek *amugdalai*, the fruit having been first carried into Italy from the Greek islands.

ALOES, the dried juice of the leaves of the aloe tree. There are several kinds of the tree, which is found in India, Arabia, and some other parts of Asia, Madagascar, the Cape of Good Hope, and the West Indies. The best aloes comes from the island of Socotra, in the Indian Ocean near the mouth of the Red Sea. Aloes is used as a medicine. The American aloe is the AGAVE.

The word aloe is from the Latin and Greek *aloë*.

ALPACA, an animal living in the mountains of Peru and of Chili. It is shaped much like a sheep, but is larger, and its color varies from grayish-white to brown and almost black. Its wool is nearly a foot long, and is soft and silky and very strong for its fineness. A great deal is sent every year to England, where it is made into shawls and several kinds of cloth. The thin cloth called alpaca is woven out of alpaca wool, mixed with silk or cotton. The alpaca is a timid and gentle animal, and lets itself be led about by those who tend it, but it is ugly to strangers.

The alpaca is a MAMMAL of the order *ruminantia*, or cud-chewing animals, and of the same family with

the camel. The word alpaca is Spanish, and is made from *paco*, the Peruvian name of the animal.

ALPHABET. This word is made out of the Greek names of the first two letters of the alphabet, *alpha* and *beta* (A and B); so when we say alphabet, we merely say A B. All alphabets are not alike. In the English alphabet and many others there are letters for the sounds of both the vowels and the consonants; but in the Hebrew alphabet there are letters for the consonants only, the vowels being marked by slight changes in some of the consonant letters. Some alphabets, like that of the Cherokee Indians, have a letter for each syllable. In the writing of the Chinese, who have no proper alphabet, there is a character or sign for every word in the language.

The alphabets of most of the European languages are much like each other. This is because they came from the same source, nearly all of them having grown out of the alphabet used by the Romans. The Romans got theirs from the Greeks, and the Greek alphabet was made out of the Phœnician, which is told about in the article WRITING. In most of the European alphabets the letters are placed nearly as they are in English, but as some of the languages do not have all of the English sounds they want a few of our letters. Thus, the Italians have no K, W, X, and Y, the Spanish and Portuguese no K and W, and the French no W. The Russian language has many sounds not found in the other languages, and has thirty-six letters, many of which are shaped differently from those of other alphabets.

In English printing many alphabets of variously formed letters are used, but they all have the same meaning. The letters most used in books and newspapers are called Roman letters, because they are like those used by the Romans. But the Romans had no small letters like ours; all their letters were capitals. The slanting letters which we call Italics, came into use about the year 1500. They were named Italics by Aldus Manutius, an Italian printer, who first made them. Script letters are also slanting, but they are made like letters written with a pen. Some of the other alphabets used in printing are:

Old English, or	Black Letter.
German Text.	Gothic.
Full Face.	**Antique.**

The different sizes of common Roman type are shown in the article TYPE.

ALUM, a whitish, salty substance largely used in the arts. Alum is sometimes found pure in the earth, but most of it is made from alum rocks and alum earth. The material is first roasted with fire in heaps and then mixed with hot water in great pans; the liquid is afterward drawn off and boiled down until most of the water passes off in steam and only the solid part is left.

Alum is used largely in medicine. It is also employed by bakers to whiten bread made from poor flour, by sugar-makers for whitening sugar, by dyers to fix colors, and by tanners in preparing skins and in coloring morocco.

Alum is a SALT made up of alumina (see ALUMINUM), POTASH, SULPHURIC ACID, and water.

The word alum is a short form of the Latin *alumen.*

ALUMINUM, a METAL, one of the ELEMENTS. When pure it is bright bluish-white, nearly the color of tin, about a fourth as heavy as silver and a third as heavy as iron or steel, does not oxidize or rust in either damp or dry air, and is not changed by water. It melts at a lower heat than silver and a higher heat than zinc. It is as hard as zinc, yet may be hammered out into thin sheets like gold and drawn into fine wire. Aluminum is the most abundant of the metals and, with the exception of

OXYGEN and SILICON, the most abundant thing in the world, being found in clay, marl, slate, feldspar, granite, and nearly 200 other minerals. For a long time no cheap way of getting this metal was known (though every cubic yard of clay, weighing about 4000 pounds, is said to contain 900 pounds of it), and it cost nearly as much as silver; but a way has been found out of making it directly from a kind of clay called bauxite, and it can now be manufactured in large quantities at less than the cost of copper. It is much used in the arts, especially for making opera-glasses, telescopes, and other kinds of scientific instruments, sword hilts and sheaths, the metal parts of soldiers' uniforms, cooking utensils, photographic apparatus, and statuettes and other works of art. The metallic parts of balloons also are made of it, and if a flying-machine is ever made it will probably be of aluminum on account of its lightness. The pointed cap of the Washington monument, also the tip of its lightning rod, is the largest casting ever made of aluminum, which is a good conductor of electricity.

A good deal has been said about aluminum taking the place of steel in building ships and other great works, but as it is only about one-third as strong as steel this will probably never be, though it may be thus used when mixed with other metals.

Aluminum Bronze, an ALLOY of nine parts of copper and one part of aluminum, looks much like gold, though it is more apt to tarnish. It is very hard and as strong as steel, but can easily be hammered or drawn into wire. Imitation jewelry, watch-cases, and other ornamental work are made of it, and it is also much used for the bearings of machinery, that is, the parts most easily worn.

Aluminum Silver, made up of aluminum and a little silver, is much used instead of silver for making candlesticks and candelabra, harness ornaments, drinking cups, spoons and forks, and other common things, because it does not tarnish like silver.

Aluminum forms alloys also with tin, zinc, nickel, and iron. When mixed with tin it is worked more readily, and is more easily soldered. A little aluminum mixed with iron or steel makes it melt and flow easier, so as to make better castings.

Alumina (aluminum oxide) is formed by the union of oxygen with aluminum. When pure it is a light, white powder, without taste or smell, and will not melt in any common fire. It is the most common of all earths, and is the chief thing in CLAY. EMERY is nearly pure alumina, and the ruby and sapphire are made up of alumina colored with oxides or rusts of different metals. Topaz, lapis lazuli, turquoise, and CORUNDUM are also mostly alumina.

Aluminum gets its name from the Latin *alumen*, a term applied by the Romans to all things having an astringent taste, like alum.

AMALGAM, an ALLOY of metals, one of which is MERCURY. Mercury, which is also called quicksilver, has the power to dissolve most other metals and mix with them. This causes it to be much used in separating gold and silver from their ores. In gold mining, the quartz rock in which the gold is mixed in little grains is crushed into small pieces and then washed through several machines in which mercury is put. The mercury takes up all the little pieces of gold and mixes with them, while the earthy matter is washed away. The mercury is then driven off by heat, as is explained in the article MERCURY, and the gold is left. The same process, which is called amalgamation, is used in silver mining. Amalgams are largely made use of in the arts. Metals are sometimes gilded by washing them with an amalgam

of gold and mercury; the mercury is then driven off by heat, leaving the gold on the metal. For the way of silvering looking-glasses with an amalgam of tin and mercury, see MIRROR.

The word amalgam is from the Greek word *malagma*, a poultice.

AMBER, a hard, light, yellow, substance, often clouded with white, the hardened gum of a kind of pine tree which does not grow now. It is found in small quantities in many parts of the world, as on the coasts of the Adriatic Sea and Sicily, in Siberia and Greenland, and in the United States in New Jersey, Massachusetts, and Maryland; but most of the amber sold comes from the Prussian coasts of the Baltic Sea. Some is dug out of the ground, and some is picked up on the shores where it is washed up during storms, but the greater part is got out of the sea itself. It is supposed that in ancient times the climate of North Germany was much warmer than it is now, and that the coast of the Baltic was covered with a great pine forest. Pieces of the bark and cones of these trees are often found sticking to the amber, and many insects belonging to a warm climate, of kinds which do not live now, are also found in it. It is said that 800 kinds of insects and 150 kinds of extinct plants have been found in amber. Pieces thus marked are valued more than plain pieces. Much of the amber taken from the sea is found sticking to sea-weed. After an easterly storm, even in the coldest weather, the peasant men stand in the water and throw the sea-weed with forks upon the sand, where the women and children pick off the pieces of amber. Out in the sea a good many dredging machines (see DREDGE) are all the time at work tearing up the sea-weed from the bottom and digging up the mud, both of which are brought up and carefully searched for amber. Lately, men clothed in diving armor, much like that shown in the picture in the article DIVING-BELL, have been employed in getting it, with great success.

Amber is usually found only in small pieces, from the size of a grain of wheat up to that of a hen's egg. The largest piece ever found, now in the museum in Berlin, is about as large as a child's head. Amber is much used for making ornaments, such as beads, necklaces, ear-rings, pendants, etc, for the mouth-pieces of pipes and cigar-holders, and for burning for perfume. A good deal is sent to Mecca, where it is burned as incense by Mohammedans in their worship, and refuse amber is now made into a very fine varnish.

If a piece of amber be rubbed until it gets warm and then put near some small pieces of paper or cotton they will fly toward it, cling to it for a moment, and then fly off again. This is caused by the ELECTRICITY in the amber, which is stirred up by the rubbing. There is so much electricity in it that the workmen who make things out of amber have to change the pieces often to keep it from hurting them. The Greeks, who knew that amber would act in this way, named it *electron*, and out of this word was made our word electricity.

The word amber is from the Arabic word *anbar*, AMBERGRIS; ambergris was first called anbar, and the name was finally given to yellow amber because it looks somewhat like it.

AMBERGRIS, a gray, fatty substance, used as a perfume, sometimes found floating in the sea, and sometimes in the intestines of the sperm whale. It is formed by the indigestion of part of the whale's food, and pieces of mussels or of fish are often found inside of it. Usually only a few ounces are got from a whale, but as much as a hundred pounds have been found. Ambergris sometimes floats ashore and is picked up on the beach, especially in the Bahama Islands, India, Madagascar, Japan, and Brazil. Foxes have a great liking for it, and often search for it along the

sea-shore, swallowing every bit they can find. It passes through them unchanged excepting in color, its gray tint having become a clear white. This is the white ambergris, which is the most prized of all. It is sometimes found in southwestern France, far away from the sea, and it is there called by the peasants *ambre renardé* (foxed amber).

Ambergris sells for about $5 an ounce. When mixed with alcohol it makes a very delicate perfume, and it has the power of making other perfumes smell stronger.

The word ambergris is from the French *ambregris*, gray amber, which is made up of the Arabian *anbar*, AMBER, and the French *gris*, gray.

AMBULANCE, a movable hospital for the immediate care of sick or wounded persons. In ancient times and until quite modern times the wounded on the field of battle were left to the care of camp-followers, or of friends who looked after them. The French first set up movable hospitals, with surgeons to attend them, in the time of Henry IV. In the war with Germany (1870–71) they had two kinds, one fitted up in some public building, and another kind on wheels to accompany the soldiers on the field of battle and remove them when wounded. Both these kinds were called ambulances. In the civil war in the United States the name was given only to the spring wagons, fitted with beds, surgical instruments, and necessary things to care for the wounded, which followed the troops wherever they went. Similar wagons are now used in large cities to carry to the hospital persons wounded or taken ill in the streets. They are generally accompanied by a surgeon, and carry lint, plaster, bandages, etc., for use in case of need. They have the right of way in the streets, and the driver strikes a gong to warn other vehicles to give him a free passage, so that he can drive fast.

The word ambulance is from the Latin *ambulare*, to walk.

AMETHYST, a kind of violet or purple rock crystal or QUARTZ, much used for making seals, rings, and other ornaments. The ancients made vases and cups out of it. The finest amethyst comes from India, Ceylon, and Brazil. The Oriental amethyst, a very valuable precious stone, of a fine violet color, is a SAPPHIRE.

The word amethyst is from the Greek *amethustos*, preventing drunkenness, because the ancients believed that liquor drunk out of cups made of amethyst would not intoxicate.

AMMONIA, an ALKALI much used in the arts. In its pure state, and at the common heat and pressure, it is a strong colorless gas (see ELEMENT) but it may easily be made into a liquid or a solid. Liquid ammonia is usually made by mixing the gas with water. It is commonly called "spirits of hartshorn" because it was formerly made by distillation (see ALCOHOL) from the horns of the hart or stag. It is now made mostly from the waste tar water of gas works. The salt of hartshorn, usually called "smelling salts," is carbonate of ammonia, a SALT formed by the union of CARBONIC ACID with the BASE ammonia.

Ammonia is supposed to have got its name from the temple of Ammon in Upper Egypt, near which it was made in ancient times from the dung of camels,

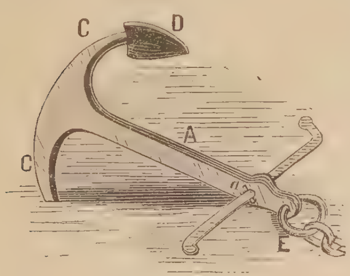
AMPHIBIANS. These animals are sometimes made an order in the class of REPTILES, but as they are really half way between reptiles and fishes they ought to be kept separate from both. Amphibians are cold-blooded ANIMALS, of small size, which live both on land and in the water. Their skin is generally naked and smooth, without any scale or shell covering as in the reptiles. They all begin life as little fish-like creatures, with large flat heads and outside gills for breathing air in

water, just as fishes do. At this time they are called tadpoles. As they grow up, little air sacs within them become large and act like lungs, enabling them to breathe common air. Some of this class, such as the sirens, do not lose their gills after they grow up, but have both gills and lungs at the same time. Amphibians differ from fishes in several things, but especially in having four limbs which are not at all like fins.

There are several orders of amphibians, but the only common ones which we need to notice are the FROGS (including tree-frogs) and the TOADS.

The word amphibians is in Latin *amphibia*, and means leading a double life, that is, in the water and on land. It is made up of two Greek words, *amphi*, or both sides, and *bios*, life.

ANCHOR, an iron hook for holding a ship by chaining her to the bottom of a harbor or road, which is hence called an "anchorage." In ancient times large stones, bags of sand, or pieces of wood weighted with lead were used for anchors. The Chinese still make use of crooked wooden anchors. Iron



Common Anchor.

anchors were first used by the Greeks. Anchors are now made of the best wrought iron. The parts of the common anchor will be seen in the picture ; A is the shank, B the stock, C C the arms, D one of the flukes, and E the ring or shackle. Once the stock was made of wood, but it is now generally of iron, with one end bent down, as shown in the picture. By pulling out the pin *a* the stock may be pushed through the shank and laid down upon it, so as to make the anchor easier to carry.

The word anchor comes from the Latin *anchora*, Greek *angkura*.

ANCHOVY, a small fish caught in the Mediterranean Sea in May, June, and July. The fishermen go out in

Anchovy.

the night, carrying torches in their boats. The fish see the light and swim up to the boats in great numbers, when they are scooped up with nets. After being cleaned they are packed in brine in small barrels and sent to other countries, where they are usually taken out and put into bottles. The anchovy looks like the herring, but is not more than three inches long. It is eaten raw, as a relish, or made into sauce. Anchovy sauce has been used since the time of the ancient Romans, who called it *garum*. A kind of anchovy is plentiful along the coast of the United States.

The word anchovy comes from the Spanish *anchova*, from an old word meaning a dried or pickled fish.

ANIMAL. Animals differ generally from plants in being able to move from place to place, though there are some animals which have not this power. Every kind of animal has some place on the earth where it lives best, so that the earth's surface may be divided up into parts, each of which has its own animals. All of those which belong to any one country are called the fauna of that country. The fauna of warm and

moist climates is much more plentiful than that of cold and dry climates, and that of the sea is more plentiful than that of the land. Most animals live in the light, but some live in places where there is no light, as in caves. Such ones do not have fully formed eyes, as they have no use for them.

All animals are classed together in one great body called the Animal Kingdom (see ELEMENT). This is divided into four sub-kingdoms: I. **Vertebrates**; II. **Articulates**; III. **Mollusks**; IV. **Radiates**, the last three of which are usually called invertebrates. Each of these sub-kingdoms is again divided into several classes; classes are divided into orders; and orders are divided into families. For example, the wolf belongs to the dog family; the dog family belongs to the order *carnivora*, or flesheaters; the order *carnivora* belongs to the class *mammalia*, or MAMMALS; and the class *mammalia* belongs to the sub-kingdom of the vertebrates.

I. **Vertebrates** have an inside skeleton, the back-bone in which is called the vertebral or spinal column. This is found in man, in quadrupeds or four-footed animals, in birds, in reptiles, in amphibians, and in fishes. The skeletons of all of these differ in many things, but they are alike in having a back-bone or vertebral column. This is made up of many bones fitting together, each one of which is called a vertebra (Latin *vertebra*, plural *vertebræ*, a joint, from *vertere*, to turn, because each one turns on the other). The number and shape of the vertebræ differ greatly. In the back-bone of man there are but 24 vertebræ, while in that of some snakes there are more than 400. A human vertebra is shown in Fig. 1: *a* is the front part, and *b* the sharp rear part which you feel when you rub your hand up and down your back. All vertebrate animals are alike also in having red BLOOD, moved by a heart, and a brain with a spinal marrow or spinal cord, as it is sometimes called. The round hole, *c*, in the vertebra fits on to a like one in the next vertebra, so that when all are joined together a

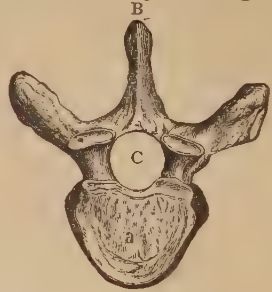


Fig. 1.—Vertebra of Man.

passage or tube is formed through the whole spinal column. In this lies the spinal marrow from which all the NERVES branch to the different parts of the body.

The vertebrates are divided into five classes: 1. MAMMALS: 2. BIRDS; 3. REPTILES; 4. AMPHIBIANS; 5. FISHES. Of these, mammals and birds are called warm-blooded animals, because their blood keeps warm even when the air is very cool, and reptiles, amphibians, and fishes cold-blooded animals, because their blood differs with the warmth and coolness of the air or water in which they live. The blood of a fish or a frog is just as cool as the water in which it swims, and this is why those animals feel cold to our hands.

II. **Articulates** include all animals whose bodies are made up of rings jointed together. These rings are easily seen in the picture of a worm,

Fig. 2.—Worm, showing Rings.

Fig. 2, whose body is wholly made up of them. When a lobster shell is dry it will break up into many perfect rings. Articulates have no inside skeleton, like the vertebrates,

but their outside shell answers the same purpose, all the MUSCLES being fastened to it. The articulates differ also from the vertebrates in their nerves. They have no brain and no spinal cord, but a kind of chain of nerves, with little knots along it, with other nerves leading from them to the different parts of the body. They have too no heart, and, with a few exceptions, their blood is white. They are divided into five classes: 1. INSECTS; 2. Arachnids, or SPIDERS (including scorpions and mites); 3. CRUSTACEANS, of which the principal order is the *decapoda* (ten-footed, from Greek *deka*, ten, and *pous*, foot), in which are CRABS, LOBSTERS, SHRIMPS, etc.; 4. Miriapods (centipedes, etc.); 5. WORMS. The word articulate is in Latin *articulata*, which is from *artus*, a joint.

III. **Mollusks** are soft-bodied animals, most of which have shells, but some of which are naked. The shell is not an outside skeleton, like the shells of the articulates, but only a protection for the body. Mollusks generally have no limbs. Their bodies are flabby, and have a soft skin which often hangs over around them in thick folds, forming what is called the mantle. This is easily seen in the oyster and the clam. The lime (CALCIUM carbonate) from which the SHELL is made is taken up from the water in which the animal lives and spread around by means of the mantle in layers on the inside. The blood of mollusks is nearly colorless, but has sometimes a light blue or greenish tinge. Their NERVES grow out of little lumps called nerve knots which are arranged differently in different kinds of mollusks. Most mollusks cannot move, but have to stay always in one place and get their food as they can when the waves and currents bring it to them.

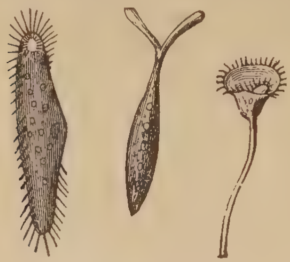
IV. **Radiates** are named from the radiated or star-like form of their bodies. STAR FISH are good examples of them. Other radiates are CORAL animals, sea anemones (see AQUARIUM), and JELLY FISH. In former times many of the class were supposed to be plants, and they are very much like vegetables in some things. None of them have a head, and though some of them move about, others always stay in the place where they grow, some of them being fixed like plants on a common trunk. Many radiates have the power of giving out the light called phosphorescence, so often seen in the sea at night. When the sea is calm its surface looks as if sprinkled with fine stars, and when the water is rough the waves roll like billows of fire. Sometimes this light is milky white or bluish.

The word radiates is in Latin *radiata*, which comes from *radius*, a ray. Phosphorescence is made from the Greek word *phosphoros*, light-bringer, which comes from *phos*, light, and *pherein*, to bring.

SPONGES are sometimes put into this class, and sometimes into a class of their own called Protozoans, meaning first or earliest animals, from the Greek words *protos*, first, and *zoon*, animal.

ANIMALCULE, an animal so small that it can be seen well only with a MICROSCOPE. Some animalcules can just be seen with the naked eye, but most of them are so small that if it were not for the microscope we would not even know that there are such things in the world. If a single drop of water be put under a microscope it will be seen to swarm with living things, some of which are no thicker than a single hair, and some are so small that many thousands of them would not take up any more room than a grain of sand. Three common forms of animalcules are shown in the first picture. There are thousands of kinds of these little animals of many different shapes. Some are like long slender lines, some coiled up like a watch spring, some like triangles, some round like a ball,

some round and flat, some like seeds, and some are shaped like bells, funnels, thimbles, drums, shoes, and many other things. They appear to



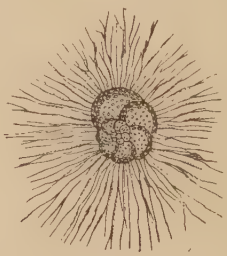
Animalcules, magnified.

be always moving, day and night, and never taking any rest. Some of them move straight forward like an arrow so quickly that they can hardly be seen, while some drag their bodies along slowly like a worm ; some buzz round like a wheel, some crawl like a snake, and some move in little leaps. The water of every ditch, pond, and river is full of them, whether in cold or in hot countries, and there are as many in salt as in fresh water. They are found too in the water of hot springs and in the ice of the Arctic regions.

Not only are all kinds of animal and vegetable matter seen, under the microscope, to be full of living animalcules, but the shells of thousands

Shell Animalcule.

of dead kinds are found in many forms of mineral matter. Large parts of some kinds of rocks, of sand, mud, and dust, are made up of the remains of these little animals which lived and died ages ago. A piece of chalk as large as a walnut has in it hundreds of thousands of little shells which were once the homes of animalcules. The building stone used in Paris and many other kinds of of building stone are full of like shells, and the rotten stone called tripoli is made up of shells so small that thousands of millions are found in a single inch. In some parts of the world they form nearly half the sand of the sea beach. These little shells are of many different sizes and forms, but all are very curious and beautiful when looked at with a microscope. Living forms of some of these little animals have been found in the ocean. Their bodies inside the shells are made up of a jelly-like substance,



Shell Animalcule.

from which little arms and feet, like threads of glass, stretch out through holes in the shell. They seize their prey with these arms, and it is supposed that there is something poisonous in them, for the animals caught appear to lose the power of moving as soon as touched. Two kinds of these shell-covered animalcules are shown in the pictures. The little threads are used also as feet when the animalcule climbs up anything.

Animalcules are the lowest kinds of animals known, none of them having NERVES or organs of sense.

The word animalcule means a small animal, and is from the Latin *animalculum*, which comes from *animal*, an animal.

ANISE SEED, the seed of a plant which grows wild in Europe and North Africa. It is cultivated in Malta, Spain, and Germany. Anise seed is used for flavoring candies and liqueurs, and is made into a cordial.

The word anise is from the Latin *anisum.*

ANNOTTO, or **ARNOTTO,** a dye made from the seeds of a small tree found in the West Indies, Brazil, and other hot parts of America. The seeds have around them a reddish-yellow pulp, which is mixed with water into a kind of putty, and made into rolls and cakes. These are used as a dye or coloring matter by dyers, painters, and soap-makers; butter, cheese, and chocolate also are colored with it, and it is sometimes put into lacquers and varnishes. At the time of the discovery of America the Indians stained their bodies with it, and the Mexicans used it for a paint.

ANT. There are several hundred kinds of ants in different parts of the world. They live in societies or families, sometimes many thousands in number, and are divided into three classes, females, males, and workers. The females are the largest, the males next in size, and the workers the smallest. The females and the males have wings, but the workers are without wings.

The male ants have no work to do. After they have paired with the females, they go off where they please and soon after die. The females lay little eggs, so small that they can scarcely be seen by the naked eye, scattering them about in the nest wherever they happen to be. The workers gather them up and take care of them, putting them in the sun in the morning and into a safe dry place in the nest at night, until they are hatched. The larvæ, or grubs, which come out of the eggs, are small, white worms, without any legs. They are treated in the same way as the eggs by the workers, who feed them with a liquid brought up out of their own stomachs. When the grub gets large enough it spins a web all around itself, which covers it like the cocoon of a SILKWORM. The cocoons are carried out into the sun and in at night by the workers, just as the eggs and the grubs were, until the time comes for them to be born again, when the workers cut the cocoons, and they come out perfect ants.

Besides taking care of the eggs, the grubs, and the cocoons, the working ants have to get all the food of the society, to build the houses and streets, and keep them in repair. Some of their dwellings are very wonderful. Most ants build their houses or nests in the ground, above which they rise like a cone or hill, and hence are called ant-hills. These have many little rooms in them, in stories one above another, and connected by galleries. In South America they are sometimes seen two or three times as high as a man. A kind called mining ants dig long galleries in clay, building pillars to support the roof, and thatching them with grass and heather. Carpenter ants make their houses in growing trees, boring out their cells deep into the wood, with partitions between them no thicker than a card. A kind of ant in Australia builds houses of leaves, which are brought to the place wanted by the strength of a great many working together, and then fastened with a kind of glue.

Ants are very active and very strong for their size. A man could not drag the body of a heavy horse over rocks and rough places for several miles, yet the little ant which carries off a grasshopper or a beetle does more than this. An ant will lift and carry things ten or twelve times its own weight, and will do it without appearing to be much tired. Ants too are among the most industrious of all animals. They will

work all day long, and in warm weather, if need be, at night also, building houses, taking care of their young, and laying up food. They eat different kinds of food, some liking best vegetable food and some animal. Some kinds of ants keep other insects for the food which they give, just as we keep cows for milk.

Blood-red Ant—Male.

Their cows are plant-lice, found on the leaves of plants. These little insects have a sweet, honey-like liquid within them which ants love very much. The brown garden ant may often be seen climbing up the stalks of shrubs and bushes, looking for them. When one is found the ant gently taps the louse with its feelers, and the louse gives out a drop of honey which the ant drinks, Ants also carry off these lice and shut them up in cells in their houses, taking great care of them, and feeding them just as we take care of our cattle. They carry off too and keep the larvæ of a kind of beetle, from the long hairs of which they suck some kind of juice, of which they appear to be very fond.

Blood-red Ant—Female.

In warm countries, where ants are large and plentiful, they kill and eat insects, birds, and small animals, and sometimes even drive people from towns. In the warm parts of America is a small shining red ant called the fire-ant, whose sting is said to be like a prick from a red-hot needle. These ants dig galleries through the ground, overrun houses, and eat up food and clothes. People who live where they are have to smear the legs of tables, chairs, and stools with copaiba balsam, which the ants do not like, to keep them from climbing up them. All food has to be hung up in baskets held by cords soaked in the same balsam, and all kinds of clothes have to be kept with great care, for they will eat even linen for the sake of the starch in it. Sometimes these ants become such pests that villages are deserted by their inhabitants. The little red ant of the United States is also a great pest in houses, as it will eat anything which has sugar in it. The large black ant of the United States is very destructive, eating food, books, wooden things, furs, etc.

In some hot countries are large flesh-eating ants which hunt for

Blood-red Ant—Worker.

prey in great armies. Wherever they go all other animals are frightened, and try to get out of their way. As they move along in a thick mass they search under every leaf and piece of rotten wood for spiders, grasshoppers, crickets, caterpillars, maggots, and other insects, and clear the ground of all animal matter, alive or dead. When they find wasps' nests on low bushes, they run up and gnaw through the covering of the nest to get at the larvæ within, without paying any attention to the angry wasps flying about them. When they have gathered all the food they want, they march homeward again, each one carrying his part of the prey for the use of the society. In South America these ants do a great deal of good by eating up insects, and people are very glad to have them come into their

houses, which in hot weather are full of all kinds of insects that bite and sting. When the army of ants is seen coming the people leave their houses, and the ants go in and search every part, peeping into corners and cracks, dragging all living things out and killing them. When they have been through the whole house they set off again, dragging away with them cockroaches, centipedes, and even lizards and any other thing which they can carry.

Some ants make war on other kinds of ants and carry off their young and make slaves of them. These fighting ants, which are red, are mostly idle, stupid fellows who do not know how to take care of themselves, and who would starve to death if they did not have slaves to look after them; but their nippers are very sharp and strong, and well fitted for fighting. The pictures show the male, the worker, and the female of these red warrior ants. The ants on which they make war are active little black ones, who live in well-built houses, and who are hard workers. When some of the red ants find one of

Nests of Termite Ants.

these colonies, they go home and tell their friends of it, and then the red ant army sets out to attack the enemy's fort. As soon as the black ant sentinels see them coming they rush into the fort, give the alarm, and then rush quickly out again, followed by great numbers of other black ants, who fight the invaders bravely, but in vain. The red ants are the best soldiers, and they soon overcome the black ones and press into the fort. The blacks fly in all directions, and in a few minutes the reds are seen coming out again, each one carrying in its mouth an egg or a larva of the black colony. With these they march home, where they bring up their prisoners to serve them, treating them the same as their own children. They never carry off the grown-up ants, who would probably run away when they got a chance. As soon as the black ant children grow up they do all the work of the household and take the best of care of their masters. They lick them, brush them, feed them and carry them around on their backs. The masters, who do nothing but carry on

war, become so used to being waited on that, if they lost their slaves, the stupid creatures would die in the midst of plenty.

A kind of ant in Texas is said to build cities and roads, and to keep a regular army. These ants first clear away the grass for three or four feet around their city, and then make a pavement on it of coarse sand and gravel. As this would be covered with water in the rainy season, they build mounds on it about a foot high, and in these they make cells in which their eggs, young ones, and their stores of grain are carried when the rains begin. The only plant allowed to grow in the bounds of their city is a kind of grain-bearing grass, whose seeds they gather when ripe and put away for use.

Ants have many enemies. Birds and some kinds of animals eat great numbers of them, and there is a small fly which lays its eggs on their bodies, and when they hatch out the larvæ go into the bodies and live there. There is also a small kind of ant which makes chambers and galleries in the walls of the nests of some larger kinds. They are the bitter foes of the large ants, and often rush out into their nurseries and carry off some of the larvæ for food. It is just as if there was a race of ugly dwarfs living in the walls of our houses who would every now and then carry off a baby to eat. The large ants cannot get at these pests, because they are too large to go into their holes.

Termites, or white ants, are like common ants in their habits, but differ from them in many things. They live mostly in very hot countries, and do a great deal of injury, as they eat up everything that can be eaten which comes in their way. They will sometimes gnaw out all the inside of the beams in houses, leaving only a thin shell. In Africa these white ants live together in vast colonies, some burrowing in wood, some digging deep houses underground, and some building up great hills ten or twelve feet high above ground, with little hills around them, like those in the picture. The one on the right hand is cut down through the middle to show how the inside is made. These hills are built of earth softened in the jaws of the worker ants, and which, when plastered on, dries and becomes so hard that a man can stand on the top without breaking through. Hunters looking for game, and even wild animals searching for prey, sometimes mount on to them to get a view of the country. The Africans eat these ants, pounding them up into a kind of jam, which they think very delicious. There is also an animal called the scaly ant-eater, which feeds on them. It tears open the hills of the white ants, which it licks up with its long, round, sticky tongue.

Ants belong to the order *hymenoptera*, or membrane-winged INSECTS; but termites, or white ants, belong to the order *neuroptera*, or nerve-winged insects.

The word ants is changed from *amt*, which was shortned from *emmet*, the old English name of the ant. The Anglo-Saxon name is *amete*.

ANTELOPE. Many antelopes are so like deer that they can scarcely be told from them, but deer have solid horns which they shed every year, while antelopes have hollow horns, like those of sheep, goats, and oxen, which are usually not shed at all. Antelopes' horns, too, are round and curved, have rings or wrinkles running round them, and are always black. There are a great many kinds of antelopes, most of which are found in Africa, but there are also many in Asia; there is only one kind in Europe, and there are two kinds in North America.

The **Gazelles** are the most beautiful and the fleetest of the antelopes of Africa. They are usually quite small, one kind being no

larger than a hare, though some are as large as deer. They are famed for the beauty of their eyes and for the grace of their movements.

The **Gnu**, or horned horse of South Africa, which is about as large as the ass, has a body, neck, mane, and tail like a horse, the head and horns of a buffalo, and the legs of an antelope.

Gnus feed together on the plains in great droves like wild cattle. Their flesh is excellent for food.

The **Chamois**, the only antelope in Europe, is found in the Pyrenees, in the Alps, and in other mountains. It is somewhat like a large goat, but is without beard, and has two smooth black horns, about six inches long, rising straight up from the top of the brow, and bending backward at the top. The chamois does not like heat, and stays on the highest ridges and snowy valleys of the mountains, living on herbs and the shoots of shrubs. It is very swift, and easily bounds from rock to rock, going up and down steep cliffs where other animals could not keep their feet. The chamois is much hunted, although the sport is very dangerous, and the animal is not worth much when killed, its flesh not being very good. Its skin is dressed into a fine leather called chamois or shammy skin, used for undergarments, and for cleaning silver, plate glass, etc.; but most of the leather sold for chamois-skin is made of buckskin.

The **Prong-Horn**, one of the antelopes of North America, is found in the region between the Missouri River and the mountains of the Pacific coast, especially in the prairies of Kansas, Colorado, and Nebraska. It is about as large as the common deer, and has coarse hair, yellowish-brown above, and white on the rump and under parts. The hoofs, horns, and end of the nose are black. The horns, which grow nearly straight up and bend toward each other at the top, have each a single branch or prong about half way up, and from this the animal gets its name. The prong-horn is often seen by travellers on the Pacific Railways. One will sometimes run beside a train for a mile or two, as if trying to run a race with it. Its speed is so great that it is almost useless to chase it; but it is not a hard animal to kill, because it has so much curiosity that if the hunter waves a handkerchief it will come near enough to be shot. The Indians lie flat on their backs and kick up their heels, with a rag or some other thing fastened to them, and the prong-horns, coming up to see what the strange thing is, get near enough to be killed with the bow and arrow. They are very easily tamed, and always show great affection for their master. When quite young they have little fear of man, and will often allow themselves to be caught without resisting. The little ones are very playful, and often leap about and push each other or their mother in sport, and will even play with clumps of grass or tall weeds if they can find no other companions. One day a farmer, on going after two calves that he had left in a secluded place, was surprised and amused to see two pronghorn kids frolicking with them, while the mother antelope stood gravely by watching the antics with great apparent pleasure.

The **Rocky Mountain Goat**, the other American antelope, lives in the wildest and most rugged parts of the Rocky Mountains, seldom coming down into the plains. It is about as large as a sheep, and has a beard like a goat, but its horns are like those of the chamois. Its body is covered next to the skin with a fine silk-like wool, over which are long shaggy hairs.

The antelope is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word antelope comes from the Greek *antholops*, which is made up from *anthos*, beauty, and *ops* the

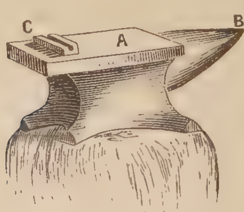
eye. The animal thus gets its name from the beauty of its eyes.

ANTIMONY, one of the ELEMENTS. When pure, antimony is bluish-white. It is very brittle, and may easily be pounded to powder in a mortar. It is sometimes found by itself, but oftener united with other things, such as arsenic, nickel, silver, and sulphur. Most of the antimony of commerce is got from an ore called gray antimony, in which it is largely mixed with sulphur. It is made mostly in Germany, from ores found there, and in Great Britain, from ores brought from Borneo and Sumatra. Antimony is given as a medicine, chiefly in the form of a white powder called tartar emetic. It is not used in the arts by itself, but makes a part of many ALLOYS. Among these are TYPE METAL and the metal used in making music plates and stereotype plates, Britannia metal, and PEWTER.

The word antimony comes from the New Latin *antimonium*.

ANTHRACITE. See COAL.

ANVIL, an iron block with a smooth face and a horn, or pointed end, on which smiths hammer and shape their work. Anvils are of many sizes, from the small ones used by goldsmiths, which are made of steel, to the immense cast-iron ones used under steam HAMMERS, which are so large and heavy that they have to be put upon stone piers built in the most solid manner in deep holes dug in the earth. Common anvils are made of cast-iron covered with steel. Some have a hole in them, made when they are cast, to let the air in so that they may cool quickly, as this makes them harder.



Blacksmith's Anvil.

In the picture, A is the face of the anvil, B is the horn, and C is a groove in which a rod of iron can be shaped round. This piece, which fits into a square hole in the face, can be taken off, and a short chisel, on which a bar of iron may be cut in two, put in its place.

The word anvil comes from the Anglo-Saxon *anfilt*.

APE, a kind of monkey without a tail. When an ape stands upon its hind legs, its arms almost touch the ground. The fingers and toes are the same on the feet as on the hands, so that apes really have four hands. They can thus grasp the limbs of trees with great ease, and jump from bough to bough without danger of falling. When wild they are the spryest of all creatures. Many of their actions are much like those of human beings, whom they often mimic. When they rest they do not squat down, like other monkeys, but stretch themselves out at full length with their heads on their hands, or on something for a pillow. Other animals fight with their teeth and claws, but apes will throw stones and use sticks and clubs like a man.

Gorilla.

The **Gorilla** is the strongest, fiercest, and most active of the apes. It is found only in the wilds of the

hottest parts of Africa. When it stands upright, it is as tall and as large as a man. The male gorilla is very ferocious, and when wounded is said to be more terrible than the lion. It can twist a musket-barrel in its jaws, and kill a man with one blow of its paw. When attacking an enemy gorillas walk on their hind legs, beat their breasts with their arms, and roar loudly. Several young gorillas have been taken alive, but none of them have lived long, for they cannot be tamed.

The **Chimpanzee,** another very large ape, nearly as tall as a man,

Chimpanzee.

is found only in Africa. It is the cleverest of all the apes, and the most like man. Chimpanzees live in societies in the forests, where they build huts of bark, branches, and leaves. They join together in bodies to defend their homes, and drive off even elephants with clubs and stones.

The **Orang-outang** is also nearly as high as a man when it stands up, and is even stronger than the chimpanzee. It is found in Southern Asia and in the islands of Borneo and Sumatra. Orang-outangs build nests in trees, and do not leave them in the morning until the sun has dried up the dew and warmed the air. They do not live in troops like the chimpanzee, excepting when a pair have a family. They live mostly on fruits, nuts, and tender shoots, and spend much of their time in trees. Orang-outangs may be tamed, and they are often affectionate in captivity, but are generally grave and sober.

The ape is a MAMMAL of the order *quadrumana*, or four-handed animals, and belongs to the same family with the MONKEY.

The word ape comes from the Anglo-Saxon *apa*.

APPLE. There were no apples in America when it was first settled, but the English brought trees, and they are now plenty all over the United States. Apples that grow in the Eastern States are richer in taste than those from the Western States, though Western Apples are larger and better looking. American apples are now sent in large quantities to Europe, China, and India. The kinds most sent are Rhode Island Greenings, Baldwins, Newtown Pippins, Spitzenbergs, and Swaars. Crab apples, which are not larger than plums, are much used for preserves. The Siberian crab apple is the best. All the kinds of apples now known are supposed to have grown from the wild crab apple tree. Apple-tree wood is much used by turners, mostly for making shoe lasts and weavers' shuttles. The Hebrews did not have the apple. The fruit called apple in the Bible is supposed to have been a kind of melon; but it has been known in Europe from the earliest times. The Greeks and the Romans cut and dried apples for winter use, and made them into CIDER. Apples were grown in Eng-

land in the Saxon times, and apple fritters were made there in the fourteenth century.

The **Custard Apple,** which grows in South America, the West Indies, Africa, and the East Indies, is a fruit with a juicy pulp which, when ripe, has the flavor of clotted cream and sugar. Some are small and some grow as large as a melon.

The **Alligator Apple** is a fruit somewhat like the custard apple, but is not so good.

The **Mammee Apple,** which grows in the West Indies and other hot parts of America, is an angular fruit as large as a cocoanut. It has two rhinds, an outer thick one and an inner thin one, sticking close to the flesh, which is bright yellow and has a pleasant taste and sweet smell. It contains three or four large seeds, from which the Indians make hair oil.

The word apple comes from the Anglo-Saxon *appel*.

APRICOT, a fruit that looks like a peach, but has the stone of a plum. The tree grows wild in China, whence it spread westward. It was first brought into Europe in the time of Alexander the Great. The Romans became acquainted with it about the time of Christ. Apricots are dried in large quantities in Italy and sent to foreign countries. Many also are dried in Bokhara and other parts of the East and sent to Russia, and the preserved apricots of Damascus are famous. The apricots that come from France in boxes, dried and preserved with sugar, are the fruit of the apricot plum. A black paint, like India ink, is made from burned apricot stones. Many apricots are now raised in California.

The word apricot comes from the old English *apricock*, perhaps from the Latin *apricus*, sunny.

APRIL. See CALENDAR.

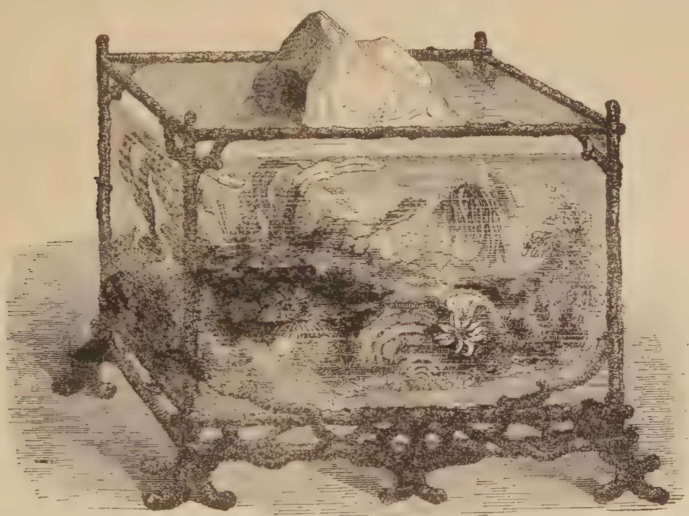
AQUA FORTIS. See NITRIC ACID.

AQUARIUM, a tank for keeping water animals and plants in. It was once thought necessary to change the water every few days in the glass vessels in which fish and other water animals are kept, because when water animals breathe they use up OXYGEN and give out CARBONIC ACID just as land animals do, and this in a short time makes the water impure. But about sixty years ago (1830) a French gentleman, M. Charles des Moulins, found out that, if water plants are put into the water with the animals, the plants will take up the carbonic acid and give off the oxygen which the animals need, just as is done in rivers and lakes, as is told about in AIR. Thus the water is kept pure, and there is no need of changing it. At first only fresh-water tanks were made, in which fresh-water animals and plants were kept, but it was soon found out that salt-water plants and animals could be kept and studied in the same way, and now many cities have large buildings filled with aquaria in which are kept all kinds of living things from seas and lakes. These give much amusement to the people, and furnish to scientific men the means of studying the habits and modes of life of many animals of which but little was before known.

Small aquaria are now often kept in houses for study and amusement, just as cages of birds are kept. They are usually fresh-water ones, as those with salt water are much harder to take care of. The one in the picture is a very good form. The bottom is made of marble, slate, or a sheet of zinc; the framework is of bronze or iron, and the four sides of plate glass. The glasses must be fitted into the frame very tightly, and fastened with water CEMENT, so that the tank will not leak. On the bottom should be put about an inch of well washed river sand, and on this pebbles should be strewn. No clay or other dirt should be put in, as it is apt to color the water. A little mountain or a grotto may be easily made with broken stone stuck

together with water cement. A part of it should come above the water, for turtles and other little animals to crawl out upon. If shells are put in they should be first burnt or well washed, so as to get all the animal matter out of them. Fresh-water plants, such as starwort, water crowfoot, duck weed, water thyme, and milfoil, should have their roots covered with the sand, and have a few pebbles put over them to keep them in place. Care must be taken not to put too many animals in a small aquarium, as there may not be air enough in the water for all. Among the most interesting and pretty of the small fishes for a fresh-water aquarium are the stickleback, gold fish, perch, minnow, tench, and gudgeon. Some small turtles are interesting, and a few MOLLUSKS, such as snails and mussels, should be put in, as they help to purify the water, by using up decaying vegetable matter.

The aquarium should not be let stand in the sunlight too much, as it will warm the water, which ought to be kept cooler than common sitting rooms in winter (the best heat is 50° to 60°). Every few days the water should be aired by dipping it up in a cup and pouring it gently back into the tank in a small stream or by blowing into it with a bellows. Nature does this by constant evaporation and rain, and also by the interchange from springs through brooks and rivers to the sea. Air thus becomes mixed with the water, and the animals have more to breathe. If an animal or plant die it should be taken out at once, for the water will be made impure by it. Some aquaria are made so that a little fresh water is always running in at the top while a small pipe carries off a little from the bottom.



Aquarium.

A salt-water aquarium should be taken care of in much the same way as a fresh-water one. Those who live near the sea can easily get new water if that in the aquarium become impure; and those who live at a distance can make it pure again by straining it through a sponge. Air must also be often put into the

water just as in fresh-water aquaria. Of course a salt-water aquarium must have in it only things which grow in salt water. Everything will thrive if you are careful to have about as much vegetable as animal matter; and it is always better to have a few healthy animals than many weak ones.

Green dulce, or sea-cabbage, is the best of the sea plants to use, and it is well to put in a few stones as large as hens' eggs, covered with green seaweed. Brown and red seaweeds are not so good. Sponges soon die in the aquarium, and spoil the water. Among the animals good for a salt-water aquarium are small fishes, such as minnows and sticklebacks, shrimps, snails, barnacles, and a few sea anemones. Sea anemones are a kind of animal plants, which have stems somewhat like the stem of a toadstool, with a jelly-like flower on the top. These flowers, which are of many colors—blue, dark red, pink-and-white, yellow, etc.—are really feelers, which stand out all round like a star, and with which the animal catches its food. Anemones fasten themselves to rocks on the bottom of the sea, with their flower feelers open, and when a little fish just hatched or a worm comes along, the feelers close up, shut it in, and carry it into its mouth, which is in the middle of the flower. It is very interesting to watch the movements of anemones, which should be fed every day with small pieces of dried meat, which may be dropped upon their feelers. They will take a great many different shapes, sometimes looking like a full-blown flower, sometimes like a bud, and sometimes like a whole vase of flowers. In the picture, which is that of a salt-water aquarium, are shown two anemones, fastened to the bottom and spreading out their flower-like heads.

The word aquarium (plural aquaria) is made from the Latin word *aqua*, water.

AQUEDUCT, a channel to carry water, generally for the supply of cities. The aqueducts of the Romans were among the greatest of their works, some of them being more than sixty miles long. They were built with a slight but regular slope, so that water would easily run down them. Where they crossed valleys or other low places they were placed upon high arches of stones; where hills were in the way they were sometimes built round them and sometimes through them in TUNNELS. Some of the aqueducts had several channels, so that two or three different streams of water flowed through them.

Rome was supplied with water by more than a dozen aqueducts, six of which were built before the time of Christ. One, built by the Emperor Augustus, and another, by Agrippa, his son-in-law, are still in use.

The largest aqueduct in the United States is that which brings the water of the Croton River to New York City. It is forty miles long, and passes through sixteen tunnels, cut mostly through solid rock. The channel through which the water flows is high enough for the tallest man to walk in. It is carried over the Harlem river on the High Bridge, which is more than a quarter of a mile long and higher than two four-story houses (116 feet). The water flows into the reservoirs in Central Park, and is carried from there in pipes all through the city.

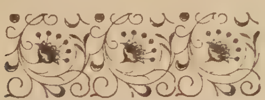
In 1883 this aqueduct was found to be too small to supply the city, which had increased greatly in population, and a second great aqueduct was built, large enough to bring in all the water of the Croton valley. This aqueduct, which was finished in 1889, is what is called a tunnel aqueduct, most of it being tunnelled through solid rock at a depth below the surface of the ground of from 50 to 425 feet. The entire length of the aqueduct is a little more than 33 miles, of which nearly 31 miles is

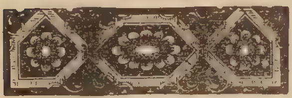
tunnel. This is the largest tunnel in the world. The conduit through which the water flows is a circle 14 feet in diameter, or nearly twice as high and wide as the old aqueduct.

Boston is supplied with water through the Cochituate Aqueduct, which is about fifteen miles long. There are many aqueducts on the Erie Canal, by means of which the waters of the canal are carried over rivers and valleys. These, which would be more properly called aqueduct bridges, as a canal itself is an aqueduct, are much wider and larger than those built to carry water to cities, and are open at the top.

The word aqueduct is from the Latin *aquæductus*, which is made up of *aqua*, water, and *ductus*, a leading.

ARABESQUE, a kind of decoration in architecture, largely used by





Arabesques.

the Spanish Moors or Arabs, from whom it got its name. As the Mohammedan religion forbade the making of pictures of animals, the Moorish arabesques were made up of vines and plants, leaves, flowers, and fruit, twisted together in all sorts of figures. Those of the palace of the Alhambra, in Granada, Spain, are the most beautiful and most famous of the Moorish arabesques. Animals, birds, insects, and even human figures are now put into arabesque decorations, which are much used in fresco painting.

The word arabesque is French, and is from the Latin *Arabicus*, Arabian.

ARCH. The arch shown in the picture is a semicircular (half circle) arch. It is formed of wedge-shaped blocks piled up from two sides, facing each other, with the narrow part of the wedge on the inside, so that the blocks on the two sides come

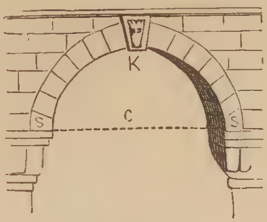


Fig. 1—Semi-circular or Round Arch.

nearer and nearer to each other until they meet at the top. The stone in the middle, K, is called the keystone, because it locks the whole together; if it were taken out the arch would fall down. The two bottom stones, S S, are the springers, and the flat stones under the springers are called the imposts or platbands. The distance across the widest part of the arch on the line C is the span, and the distance between the span and the keystone is the height. In building an arch a wooden frame is first put up, shaped on the top just like the arch, and the stones are piled up on it until they meet at the top and the keystone is put in, when the framework is taken down and the

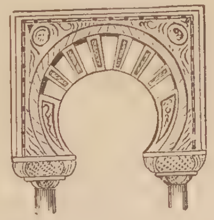


Fig. 2.—Horseshoe Arch.

arch stands by itself. The round arch is often called the Roman arch because that in the Cloaca Maxima (Great Sewer) at Rome, said to have been built by Tarquinius Priscus

about 600 B. C., was long supposed to be the oldest one in the world; but it is now known that the Chaldeans and the Assyrians understood both the round and the pointed

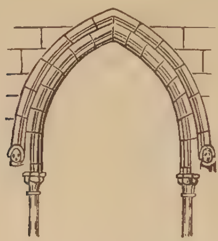


Fig. 3.—Gothic Arch.

arch, and that the arch was common in the great buildings of Babylon and Nineveh. The Arabs first made the horseshoe arch, Fig. 2, which is used so much in Moorish architecture. The pointed or Gothic arch, Fig. 3, was first used in church architecture about the latter part of the twelfth century. A still more pointed form of it is called the lancet arch.

Arch of Triumph. The Romans were the first to build triumphal arches. When a victorious general was given a triumph, the procession in his honor always entered the city through the Porta Triumphalis (Triumphal Gate), which was decorated in his honor with trophies and other memorials of his victory. In time other arches were erected in Rome and in other cities to celebrate triumphs and some in honor of victories for which there had been no triumph, and finally, some even for other things than victories. Thus, the arch at Ancona was erected in honor of Trajan because he improved the harbor at his own expense. Three real triumphal arches are still standing in Rome: the arches of Titus, of Septimius Severus, and of Constantine. The finest modern triumphal arch is the Arc de l'Étoile (Arch of the Star, because streets radiate from it), erected, in honor of his victories, by Napoleon in the Champs Élysées, Paris. The Brandenburg Gate, at the end of the street called Unter den Linden, Berlin, is really an arch of triumph. An arch of triumph was erected in New York on Washington Square, at the foot of Fifth Avenue, in 1891-92, in honor of the centennial celebration of the adoption of the Constitution of the United States; and another one of granite in Brooklyn, at the west entrance of Prospect Park, in honor of "the defenders of the Union, 1861-1865."

The word arch is from the Latin *arcus*, a bough.

ARCHITECTURE means the art of building both for use and for beauty. Vitruvius, the Roman writer on architecture, and the only ancient writer on the art whose works have come down to us, says that three qualities are necessary in a fine building: strength, use, and beauty. Men at first lived in CAVES or wherever shelter could be found, in huts covered with the branches of trees or in tents made of the skins of beasts, and finally learned to build houses of wood and stone. Some of the earliest houses were built on piles in the water, told about in LAKE DWELLINGS.

Fig. 1.—Dolmen.

How the art of architecture rose out of these rude beginnings we do not exactly know, but it is certain that it grew slowly, and that most of the ancient countries invented forms or styles peculiar each to itself, differing

in many respects from the architecture of neighboring countries.

Prehistoric Architecture. The structures erected before the beginning of history have little architectural value. Some of the oldest are monoliths (Greek *monos*, single, and *lithos*, stone), or single upright stones and triliths (Greek *treis*, three, and *lithos*), two single stones set up with a third one laid across the tops. Sometimes many single stones were set up in a great circle, as at Avebury in England, and sometimes triliths were thus placed, as at Stonehenge. A dolmen (Fig. 1) is a kind of rude stone table, formed of a large flat stone supported by upright ones. Many of these are found in Great Britain, France, Algeria, and India. Other forms of prehistoric architecture were stone huts made pointed like a beehive, stone towers, and burial places.

Egyptian Architecture. The buildings of Egypt are among the earliest in history. One of the first and greatest works in the world is the Great Pyramid of Ghizeh, built about 4000 B. C., which is said to have taken the labor of 100,000 men for twenty years. It covers nearly thirteen acres and is 486 feet high, or a little less than the Washington Monument, and fifty feet higher than St. Peter's in Rome. It cost about

Fig. 2.—Section of Great Hall at Karnak.

$42,500,000. Herodotus says it was built by a king named Cheops as a tomb for himself; near it his successor, called Chefren by Herodotus, built a second pyramid a little smaller, and a third king, Mycerinus, built a third, still smaller. Besides these, there are in Egypt nearly a hundred other pyramids, great and small. Near the pyramids of Ghizeh is the great Sphinx, with the body of a lion and the head of a man. It is 100 feet high and 146 feet long, and the head is said to be as large as 40,000 common heads.

The Labyrinth, an immense building near Lake Mœris, contained 1500 rooms below ground and 1500 above, besides great halls, courts, and gardens. The roofs were all of stone, and the walls were covered with sculptures. Herodotus says it was meant for palaces for the twelve kings. The temple at Karnak was probably the grandest building for worship ever constructed, being 1200 feet long and 360 feet wide, thus covering nearly twice the space occupied by St. Peter's at Rome, the largest of modern churches. The great hall, 340 feet long by 170 wide, is still the most wonderful apartment known. It has fourteen rows of columns, nine in each row; with two rows of large columns, six in each row, holding up the central parts,

where the light was admitted. The picture (Fig. 2) shows a section of part of this hall, each inch of which represents fifty feet of the original. The temple of Edfoo, above Thebes, though not so large as that at Karnak, is much larger than St. Paul's in London. The entrances of the temples were generally decorated with gigantic statues, some of them more than 50 feet high, and obelisks, of single stones of red granite or syenite, some more than 100 feet high.

The Egyptians were probably the first to use the column, but only in a rude way. They knew the principle of the arch, for arches as old as the pyramids have been found; but they seldom employed it in their buildings, their doors and gateways being covered by enormous stones. The dome, the cupola, and the minaret were unknown to them, all their roofs being flat.

Hebrew Architecture. Though the Hebrews lived long in Egypt and must have known about Egyptian architecture, we have no record of their constructing any large building before the days of Solomon. Some think the temple built by him (1015 B. C.) was Egyptian in style; others that it was more like the palace of Darius at Persepolis. It was not very large, being only about 110 feet long by 36 wide, and 55 feet high. In its front was a porch of the whole width of the building, 36 feet, but only 18 feet in depth. The entire building was gilded or overlaid with gold, and the roof was tiled with gold. In the time of Cyrus (568–529 B. C.) this temple was rebuilt, and the second temple also was pulled down by Herod, who built a new one of the same size as that of Solomon, but nearly twice as high. He made the porch, too, five times as long as the old one, or 180 feet, and of the same height. Herod's temple, the one destroyed by Titus, 70 A. D., was built of white marble.

Indian Architecture. The early religion of India was Brahminism, but in the third century before Christ a king named Asoka changed the religion to Buddhism. Of about a thousand temples in India, a tenth probably are Brahminical and the rest Buddhist. Not one of these is built; all are rock-hewn caves. The most wonderful are at Ellora, near Aurungabad, which extend three or four miles underground. The roofs are solid rock, supported by pillars carved out of the rock. The Kylas temple at Ellora, built about 1000 A. D. by the Jains, a sect of Brahmins who tried to restore the Brahmin religion, is a splendid structure 270 feet deep by 150 wide, and just such a temple as would be built out of stone, but all carved out of the solid rock. The rock-cut Buddhist monasteries are even more numerous than the temples. The latest Hindus built temples or pagodas, the finest specimen of which is that at Tanjore. It stands on a base 83 feet square, and rises fourteen stories, each smaller than the one under it, nearly 200 feet.

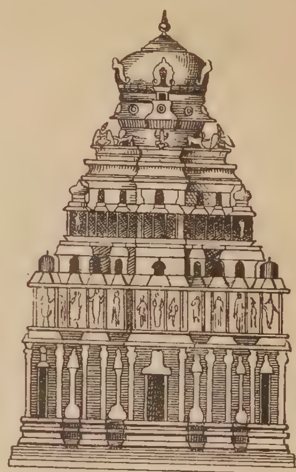


Fig. 3.—Pagoda, Tanjore.

Assyrian Architecture. The Assyrian palace-temples were rectangular buildings, on artificial mounds,

reached by flights of stone steps. The rooms and halls were not large, compared with modern ones, the largest hall in the palace of Sennacherib at Nineveh being only 200 by 45 feet. Some of them were very long and narrow, one being 218 feet long by only 25 wide, and they had very thick walls, the great hall of Nimroud, which was 32 feet wide, having walls 26 feet thick. Some think that these thick walls supported a double row of columns with a flat roof, so as to give light and air above without letting in the sun's rays. The halls were lined with sculptures carved in alabaster to a height of ten feet, with great winged human-headed bulls at the entrances. Above the sculptures the walls were of baked bricks and tiles, richly colored and glazed. The floors were of sun-dried bricks or of alabaster slabs.

Assyrian architecture was wholly different from that of Egypt. The Assyrians understood the arch, the dome, and the minaret: and in their sculptures are found representations of Ionic and Corinthian columns, which were carved long before the time of any known Greek works. From this it seems probable that the Greeks got their ideas of these columns from Assyria.

Persian Architecture was different from both Assyrian and Egyptian, though it took some things from each. Like the Assyrians the Persians used the human-headed bull for ornamentation, and their doors and windows were similar to those of Egypt. Persian columns were an advance over the Egyptian, for they had richly carved bases, with capitals different from those of any other people. The remains of Persian architecture at Susa and Persepolis are striking for their grandeur.

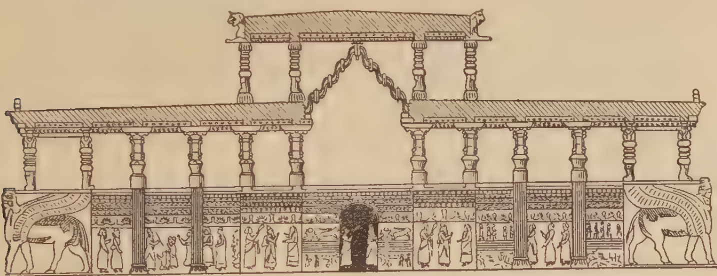


Fig. 4.—Assyrian Palace at Khorsabad : restored.

Grecian Architecture. The earliest architecture in Greece was very rude and wholly unlike what is now called Grecian. About 1800 B. C. an Asiatic people called Pelasgi went into Greece and founded several states, among them Argos and Sicyon. They built walls and structures of huge masses of rock, roughly hewn and piled up without mortar. This, named Pelasgic architecture from the people, is called also Cyclopean architecture, because it was said to have been the work of the Cyclops. Examples of it are found also in Italy and other countries. About three hundred years afterward the Hellenes, also an Asiatic people, drove out the Pelasgi from almost all parts of Greece. To the Hellenes is due Grecian architecture, which has never been surpassed in beauty of form and proportion, and in simplicity and harmony of parts. The three principal styles of Greek architecture, the Doric, the Ionic, and the Corinthian, got their names from their respective COLUMNS. Besides these,

the Greeks had another style in which the statues of women took the place of columns. These figures were called Caryatides, or women of Caria, a city of Laconia, Greece, where was a famous temple of Diana.

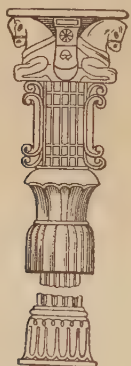


Fig. 5.—Capital and Base of Persian Column: Palace at Susa.

Vitruvius says the city having sided with the Persians after the battle of Thermopylæ, it was taken by the Greeks, who led the women away captive, and who erected trophies with the women as columns to perpetuate the event; but it is more likely that they represented priestesses of Diana. This order, called

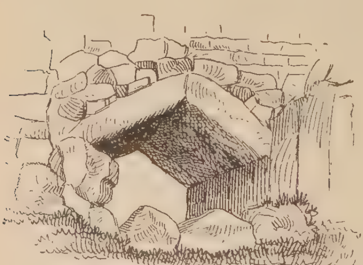


Fig. 6.—Cyclopean Arch at Delos.

the Caryatid order, the Greeks probably got from Egypt, where both human and other figures were used as columns. There is only one Greek building of this order existing, a part of the triple temple called the Erechtheum, in the Acropolis, Athens. Most of the principal Greek buildings known were of the Doric order. The exceptions were the temple on the Ilissus, the temple of Victory and the Erechtheum at Athens, the temple at Branchidæ, Ionia, the temple of Diana at Ephesus, and the Mausoleum at Halicarnassus, which were Ionic. The sole perfect example in Greece of the Corinthian order is the little building at Athens called the Choragic Monument of Lysicrates.

While the Greeks probably borrowed the idea of the column in architecture from Assyria, they greatly improved it and added all its delicate details. They were the first to use the pediment, which crowns

Fig. 7.—Caryatid. From the Erechtheum.

all their temples. If they knew the principle of the arch, they never made use of it.

Roman Architecture. Instead of the Doric, which the Greeks liked best, the Romans made the Corinthian order their national style. They did not copy exactly from the Greek, but varied it in many ways, especially in ornamentation, though without destroying its beauty. They used this order for their temples and other public buildings, not only in Rome, but in all their colonies; and, while there is only one example of

Greek Corinthian extant, many buildings of Roman Corinthian exist in various parts of the world. But whenever the Romans used the Doric or the Ionic order they debased it, spoiling the proportions which the Greeks had given them.

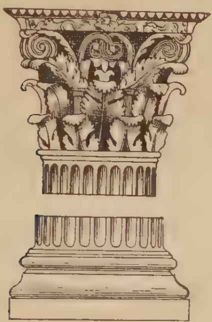


Fig. 8.—Corinthian Capital and Base from the Choragic Monument, Athens.

Most of the grandeur and splendor of Roman architecture is due to their knowledge and use of the arch, which enabled them to employ inferior

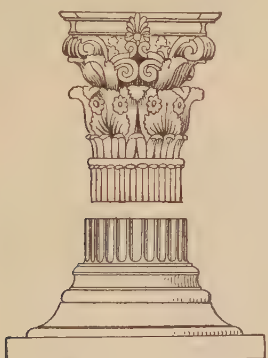


Fig. 9.—Roman Corinthian Column, Temple of Jupiter Stator, Rome.

materials. The Egyptians built chiefly with granite, the Greeks with marble, the Romans with brick. Excepting a few of the larger buildings, like the Colosseum, the Mausoleum of Hadrian, and the bridges across the Tiber, which were of stone, the Roman constructions were of brick, only their columns being of stone. The Romans added the dome and the apse to buildings, and thus greatly aided the architect's work, leading finally to Gothic or Pointed architecture.

Gothic Architecture. Roman architecture was succeeded by the Byzantine, the Saxon, the Norman, the Romanesque, and other styles, sometimes called altogether the round-arched Gothic. Byzantine architecture, named from Byzantium, is marked by the great use made of the dome. St. Mark's church at Venice and St. Sophia's at Constantinople are splendid specimens of this style,

Fig. 10.—Old Gothic.

out of which grew the Russian and the Saracen and Moorish styles. The Saracen arch, which was higher than it was wide, is thought by some to have been the origin of the pointed arch, which was not used in Europe until after the first Crusade. The peculiarities of the Moorish style, used by the Moors in Spain, were the horseshoe arch, and ARABESQUE ornamentation. Saxon, Norman, and Romanesque architecture are all marked by the use of the round or semicircular Roman arch. But this round-arched or Old Gothic style differed somewhat in different countries, each people changing it to suit its wants. Out of it finally grew, in the twelfth

century, the Pointed Gothic, in which the principal feature is the pointed arch.

Pointed Architecture. This style, called also Pointed Gothic and Christian Architecture, is generally divided into three periods: the first, dating from the latter part of the twelfth century; the second, from the beginning of the fourteenth century; and the third, from the end of the fourteenth to the sixteenth century. Like the old Gothic style, it grew up with variations in different Christian countries

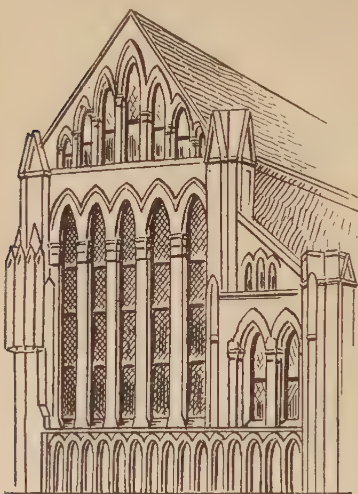


Fig. 11.—Early English.

which cannot be told about in so brief an article. In England the first period, commonly called Early English or Lancet, which succeeded the Norman, is marked by pointed or lancet arches and long narrow windows without mullions or divisions. The second period, called also the Decorated style, has large windows with pointed arches divided by mullions, and with numerous and florid ornaments. In the third period, sometimes called Florid Gothic and sometimes the Perpendicular Style, the mullions of the windows and the ornamental panellings run in perpendicular lines, making them look more straight than curved. This period is marked also by many rich ornaments, and by the splendid fan-like tracery in vaults and ceilings.

Fig. 12.—Decorated Style. East Window, Carlisle Cathedral.

The Renaissance. After the middle of the sixteenth century Pointed architecture went out of use, and a new style grew up out of a revival of the classic styles, called variously the Renaissance (Revival) and in Italy the Cinque-Cento (Fifteenth Century), because in that century the Revivers or Cinquecentists, instead of copying the remains of

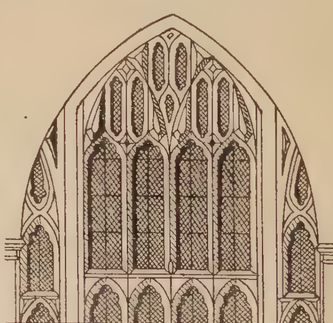


Fig. 13.—Perpendicular Style. Window in Winchester Cathedral.

Grecian art, took for their models the laws laid down by Vitruvius, and so made what they called the Five Orders of architecture, adding to the Doric, Ionic, and Corinthian styles

of the ancients another mentioned by Vitruvius—the Tuscan, a kind of Doric with a base—and a fifth, the Composite, a mixture made by themselves of the Ionic and Corinthian. The finest specimen of Renaissance architecture is St. Peter's at Rome.

The word architecture is from the Latin *architectura*, Greek *architektonia*, from *arehi*, chief, and *tekton*, worker or builder.

ARMORED SHIPS. The idea of building ships with their sides protected against the attack of an enemy is almost as old as the art of navigation. The Normans put around their ships' sides a belt of iron or brass ending in a spur in front; the crusaders protected their vessels in a singular way, covering their sides with raw hide to save them from Greek fire; and at the siege of Gibraltar in 1782 batteries covered with wood, leather, and bars of iron were used. In 1838 the United States built a steam man-of-war called the Fulton the Second, the sides of which are said to have been thinly plated with iron. In 1855 the French and English built floating batteries plated with iron for use in the Crimean war, and in 1858 the French built the Gloire, an iron-plated screw frigate. Her armor, which covered only her sides amidships, was 4½ inches thick, backed by two feet of solid timber. The building of this ship was the beginning of the modern system of armored ships. She was followed by the Normandie, the Invincible, the Couronne, the Magenta, and the Solferino; and the British built the

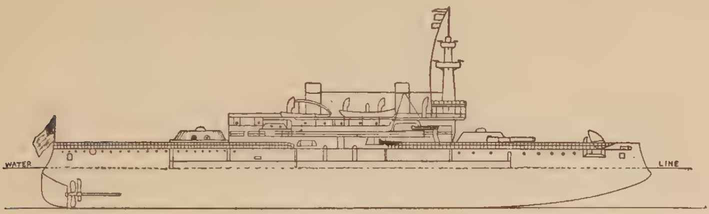


Fig. 1.—Texas.

Warrior, the Black Prince, the Defence, the Resistance, and the Queen. All these ships were on the old plan, though the hulls were built of iron instead of wood.

The Monitors. During our Civil War iron-clads were first used on the Mississippi River, which the Confederates had closed below Cairo by building batteries on the banks. The earliest used, the St. Louis, Carondelet, Cairo, Mound City, Louisville, Cincinnati, and Pittsburgh, constructed by James B. Eads in 1861, were steamboats plated with bar-iron 2½ inches thick against an oak backing. In 1862 the Confederates converted the wooden frigate Merrimac into an iron-clad ram, called the Virginia, by covering her with railroad-iron. On March 9th of that year she was met in Hampton Roads by the Monitor, a vessel built by John Ericsson of New York, and after a short fight was driven back to Norfolk. This battle changed naval construction throughout the world; and all nations began to cut down the sides of their wooden men-of-war and to plate them with iron. The United States built many vessels on the plan of the Monitor, some with one and some with two turrets, but in all of them the armor was made up of many layers of iron plates bolted together. The turret of the Monitor was eight inches thick, made of eight 1-inch plates; the Canonicus, another monitor, had 11 layers of 1-inch plates; and the Puritan and Dictator had turrets 15 inches thick. But

the English proved by experiment that plates thus made up are not so strong as solid plates, and the latter are now used by all nations.

Many vessels with turrets were then built in Europe, but higher than our monitors; for while the monitors are good for coast defence and for use in inland waters, they are so low in the water as to be unsafe for sea-going cruisers. At first these armored ships were proof against the heaviest guns; but larger and stronger guns were made until guns were able to pierce thirty inches of iron at a thousand yards' distance. The thickness of the armor had to be increased to resist these immense guns, but this added so much to the weight of the ship that it was found impossible to cover all the sides with armor, so it was put on the vital parts only along the water-line and over the battery. Compound armor was next tried, that is, iron plates with a hard steel face; and then steel armor was substituted, but, though much stronger than iron, no target has yet been found strong enough to withstand projectiles from the great rifled guns. Some think that no armor can be made that cannot be pierced, while others think that armor will yet be the winner against the power of guns. Lately steel armor plates hardened with nickel have been tried and found to be very much tougher than plates of steel only.

Classes of Armored Ships. War ships may now be classed into battle-ships, cruisers, and coast defence ships. Battle-ships are fighting ships armed with the most powerful rifled guns and protected in vital parts by steel armor from 12 to 20 inches thick. They are divided into water-tight compartments, so constructed that one or more of them may be filled without causing the sinking of the ship, and provided with steel rams or spurs intended to pierce the side of an enemy. Some of the largest battle-ships, which are built of steel, are of more than 15,000 tons burthen. They generally carry two to four immense guns of 10 to 16 inches calibre, and a secondary battery of smaller rapid-fire guns. The Texas (Fig. 1) of our navy has twelve inches of steel armor and carries two 12-inch and six 6-inch breech-loading rifles, besides smaller rapid-fire and Gatling guns. The Indiana, Massachusetts, and Oregon, called coast-line battle ships, carry four 13-inch, eight 8-inch, and four 6-inch rifles, besides smaller guns.

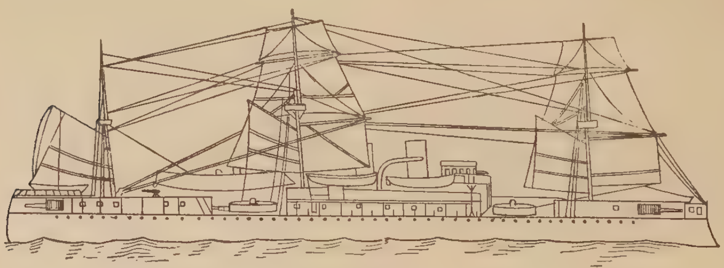


Fig. 2.—Baltimore.

Cruisers are lighter vessels intended for sea service in all parts of the world. They are very fast, and are able to carry coal enough for a very long voyage. Some cruisers are armored, like the Maine and New York in our navy, which have armor-belts on the sides of 12 inches of steel, and some, called protected cruisers, have only the

vital parts protected. Of the latter class are the Chicago, Boston, Atlanta, Charleston, Baltimore (Fig. 2) Newark, Philadelphia, San Francisco, Cincinnati, Raleigh, and others. Some of these carry four and some two 8-inch rifles, and six or eight 6-inch rifles, and some, like the Newark, Philadelphia, and San Francisco, carry twelve 6-inch rifles.

Coast defence vessels consist, in our navy, of armored vessels of the monitor type, like the Puritan (Fig. 3), Miantonomah, Terror, and Monadnock, all double-turreted monitors armed with 12-inch and 10-inch rifles. The Monterey is a somewhat similar vessel, with the same armament. Armor-clad rams, for smashing in the sides of a ship, and TORPEDO boats may also be included among vessels for coast and harbor defence.

ARROWROOT, a STARCH used as food, made from the roots and grains of several plants. The best arrowroot is got from the roots of a plant largely cultivated in the West India Islands and Central America. The roots, which are about a foot long and as large as a man's finger, are carefully peeled and beaten or ground to a pulp, and then washed in water, which takes out the starch ; this settles, and after another washing is dried in the sun. Arrowroot is made also in the East Indies, but that prepared in Bermuda and Jamaica is the best. Arrowroot which we buy in stores is often mixed with starch made from potatoes, wheat, or rice, and with sago flour. Florida arrowroot is made from the tubers or roots of the coontie root, which grows wild in the southern part of the State. The tubers, which are sometimes a foot long and three inches thick, are rough and dark on the outside, but white inside, and contain a great deal of starch. It has an acid, poisonous part, which has to be washed out before it is fit for use. The Indians use it largely for food and sell some, but theirs is not so good as that prepared by proper machinery.

Arrowroot is supposed to have got its name from the use of its roots by the Indians to cure wounds made by poisoned arrows.

Fig. 3.—Puritan.

ARSENIC, one of the ELEMENTS. When pure, arsenic is shining, steel-gray, hard, and brittle. The white powder commonly called arsenic is an oxide or rust. It is made chiefly in Silesia, in Germany, by heating an ore called arsenical pyrites. The fumes of vapors which rise from it pass into a cold chamber, where they are changed into the form of a white powder.

Arsenic is a deadly poison, and when taken into the stomach causes burning pain, vomiting, and cramps. The workmen who make it are very unhealthy. It is used to some extent in making flint GLASS, SHOT, and in other manufactures. When mixed with copper it makes a beautiful green, used in coloring paper

hangings, but these are very unhealthful, and ought not to be put upon walls.

The word arsenic is from the Greek *arsenikon*, which is made from *arsen*, strong. The name is given to it because it is a strong poison.

ARTICHOKE, a plant somewhat like a thistle, part of which is used for food. It is supposed to have first come from the countries around the Mediterranean, but it was known in England as early as the middle of the sixteenth century. The unripe flower-heads are boiled, and the fleshy lower parts of the scales or leaves eaten, dipped in olive oil or butter with a little salt and pepper. Most writers on botany now think that the artichoke has been formed by cultivation from a wild plant called the cardoon. It was not known to the Egyptians, Greeks, or Romans.

The **Jerusalem Artichoke** is a kind of sunflower, with a root like a potato. It came first from the northeast parts of America, but was known in England about the beginning of the seventeenth century. The root, the part eaten, is cooked like the potato, or eaten raw cut up with vinegar and salt.

The word artichoke is made from the Armenian words *ardi schauki*, meaning earth-thorn. The Jerusalem artichoke gets its name from *girasole*, the Italian name of sunflower, which has been thus changed in turning it into English.

ASAFŒTIDA, a kind of gum with a very strong smell and a bitter taste, the dried juice of a plant which grows in Persia and India. The plant, which is six or seven feet high, has a thick fleshy root that yields a milky juice when cut. This, when dried in the sun, becomes the drug asafœtida. The gum varies in color from red to pink and white. It is used in medicine in cases of colic, wind in the stomach, asthma, etc., In some parts of the East asafœtida is used to season curries and other food.

The word asafœtida is made up from the new Latin *asa*, a gum, and the Latin *fœtidus*, fetid or stinking.

ASBESTUS, a mineral formed of fine fibres or threads, that may be spun and woven, like cotton or flax, into cloth that will not burn in any common flame. It is made up chiefly of silica, magnesia, alumina, oxide of iron, and water. The asbestus of commerce is brought mostly from Italy and Canada, though it is found also in Switzerland, Scotland, and in Oregon and other places in the United States. In ancient times bodies to be burned on the funeral pyre were wrapped in asbestus cloth, so that the ashes of the dead might be kept separate from the wood ashes. Charlemagne is said to have had an asbestus table-cloth, and to have amused his guests by throwing it into the fire, after using, and in a short time drawing it out cleansed and uninjured. In many theatres the stage curtains and draperies are made of asbestus, so as to be fire-proof; and in Paris the firemen wear suits of asbestus cloth. Asbestus cloth is used also for covering roofs, floors, and partitions and for the linings of safes, and asbestus paint, cement, and wall-paper aid in making buildings fire-proof. Made into felt asbestus is used for packing joints in machinery to keep steam from escaping, and for covering steampipes to save the loss of heat. Firemen and stokers use asbestus gloves, and fire escapes and ropes are made of it.

Asbestus is from the Greek *asbestos*, which means endless. In Canada the French miners called it *pierre à coton*, cotton stone; the Germans call it *Steinflacks*, stone flax; and the Italians call it *amianto*, meaning that which is undefiled.

ASH, a forest tree common in Europe and North America. There are about fifty kinds of it. The most important ones in the United States are the white ash, the black ash, the

red ash, the blue ash, and the swamp ash. The white ash has the best wood; it is very hard, tough, springy, and straight-grained, and is much valued by wheelwrights, carriage-makers, ship-builders, joiners, and turners. Ploughs and other farming tools are made of it, and it is the best wood for heavy oars, and one of the best for bows. The tree bearing a red berry, which is called the mountain ash in the northern United States, is not a real ash, but belongs to another family of trees. The manna of commerce, used as a medicine, is a sugar from the sap of a kind of ash tree growing in southern Europe. It is collected principally in Sicily.

The word ash is from the Anglo-Saxon *asc*.

ASHES. When a tree grows it takes up from the earth, by means of its roots, certain minerals called SALTS. These salts, which all plants need as much as they do air, become a part of the wood of the tree. When a stick of wood is burned, the most of it is turned into gas and goes off into the air. All that is left is the ashes, which cannot burn, they being only the salts which the tree took up from the earth when growing. If the ashes be spread over the ground, the salts will go back into the earth again, and this is the reason why wood-ashes make good manure for land; the salts which have been taken from it by growing plants are given back to it in the ashes, and help other trees and plants to grow. Some kinds of wood give more ashes when burned than others. Willow wood gives more than twice as much as oak, and about one-fourth more than elm. The bark of all trees makes more ashes than the solid wood. The salts found in the ashes are valuable and are much used in the arts. The most used is POTASH, with which SOAP is made. Ashes are also used in bleaching, dyeing, and glass-making; and they are sometimes mixed with MORTAR. When mixed with salt, ashes make a very hard cement. The ashes thrown out of volcanoes are not real ashes; they are only dust and powdered stone.

The word ashes comes from the Anglo-Saxon *asca*.

ASPARAGUS, a plant grown in gardens for the sake of its tender juicy shoots, which are cooked and eaten. There was no asparagus in America before it was settled by Europeans. It grows wild in Western Asia and in Europe, but was early cultivated in gardens by the Greeks and Romans, who made great use of it for the table. It was not eaten in England until about the time of Charles I. Asparagus is not worth much for food, but is easily digested.

The word asparagus is from the Greek *asparagos*.

ASPHALT, or **ASPHALTUM,** a kind of mineral pitch or solid BITUMEN. When pure it is something like resin, both in color and hardness, but it is usually black or very dark brown. Asphalt is much used for making street pavements. It is melted in boilers, mixed with sand and gravel, and spread evenly with heavy rollers, and when cool makes a hard, solid pavement. Large quantities are used also in making floors for warehouses, cellars, etc., as a cement for sea-walls, dams, and other work under water, for roofing houses, for coating piles, the bottoms of telegraph poles and fence posts, and for painting iron-work. A kind of black varnish is made from the best asphaltum, which is used to enamel the leather called "patent leather." Artificial asphaltum is made from the coal tar of gas-works. Until lately most of the asphaltum used came from the island of Trinidad, France, and Switzerland, but since 1888 great deposits have been opened in California and Utah. The kind called gilsonite (from its discoverer, S. H. Gilson, of Salt Lake City), or uintite,

from the Uintah mountains, near which it is found, is the purest known.

The word asphalt is from the Greek *asphaltos*, bitumen.

ASS. This animal was first found in Asia, and it still runs wild in the mountains of Persia and Armenia. In ancient times the Persian kings used to hunt asses, and their flesh was thought to be excellent for food. The best asses are still brought from the East, or from Spain, where they are raised with great care. The ass is smaller than the horse, and has a rough shaggy coat of hair, and very large ears. It is sure-footed, eats coarse food, and will safely carry loads over stony mountainous regions where the horse cannot go. The ass does not neigh like the horse, but brays like the mule. The skin of the ass is very tough, and is used for covering drum-heads, making pocket-books, etc. A kind of grained LEATHER, called shagreen, is made from it in Astrakhan, a Russian city.

The ass is a MAMMAL of the order *pachydermata*, or thick-skinned animals, and of the horse family.

The word ass is from the Latin *asinus*.

AUCTION, a public sale of property to the person who offers the highest price. The salesman is called the auctioneer. The people who go to the auction make bids, or offers, one after another, for the property, which is given to the one who bids the most money. Sales by auction were first made by the Romans, who sold the spoils taken in war in this way. They first called such a sale a sale under the spear, because a spear was stuck up in the ground beside the goods; but they afterward called it *auctio*, which means an increasing, because each one who bid increased the sum offered by the one who bid before him. Perhaps, as many spears had little flags on them, an auctioneer's red flag may have grown out of the early use of the spear.

AUGER. There are many kinds of instruments for boring holes in wood. The **Brad-awl**, which is the simplest, is a round wire with a wedge-shaped edge. Some awls are made three-cornered, and some four-sided and pointed. The last is the kind mostly used by those who make bird cages. Awls do not cut out any wood when they make a hole, but only push some of it aside. Awls for making holes in leather, used by harness-makers and shoemakers, are curved or bent.

The **Gimlet** bores in a different way. It has a sharp screw-point at its end, by which it is drawn into the wood, when it is turned round, instead of being pushed in like the awl. As it goes in its sharp edge cuts a shaving from the wood round and round, and this shaving goes up the hollow of the twisted part of the gimlet, which is called the pod.

Fig. 1. Auger.

The **Auger,** like the gimlet, has a screw-point and a spiral or twisted pod, but it has also a cutting part called a lip, at each side of the end of the pod, as is shown in Fig. 1. These lips have sharp side edges, which cut the hole round, and there are other sharp edges on the bottom of the auger, called the floor-lips, which deepen the hole by cutting downward. The chips or shavings pass up the hollow spiral part of the pod, as in the gimlet. The longer the twist of the pod is, the deeper is the hole which the auger can bore; for if the twist is short, the auger has to be taken out to clear the shavings or chips soon after it is full. Some augers have lips of different shape, but the picture shows the commonest kind. Augers are made to bore holes

from one-half inch to four inches wide.

The **Auger Bit** differs from the auger in having spurs instead of lips, as shown in picture Fig. 2, where the points are seen pointing downward, instead of upward as in the lips of the auger. The spurs have sharp edges and cut a ring round the bottom of the hole, so that the floor-lips can cut out the chips more easily. Spurs are not usually put on augers, because the auger is meant to do coarser work than the bit, and the spurs might get broken off. There are several kinds of spurs used in auger-bits, some of which are curved or bent instead of being straight, and some are made with both spurs and lips. A kind of bit is also made with a movable knife having a spur on one side. This knife can be moved, by means of the screw seen in Fig. 3, so that holes of different sizes can be bored with it. Bits are made to bore holes less than a quarter of an inch to an inch and a half wide.


Fig. 2. Auger Bit.

Gimlets are usually made by hand, augers and bits by machinery. Augers and bits are made out of square rods of steel, which are hammered out and shaped by means of DIES, and twisted while red hot. The screw-point and the lips or spurs are then roughly made by machines and finished by hand. The edges of the pod are ground down so as to make them perfectly round and even, and the auger is then tempered, or hardened, by heating it hot and cooling it quickly in water, and lastly finished.

Gimlets and augers are usually fitted with handles, by which they may be turned, but auger bits are made to be used in a brace, like that in Fig. 4. The end of the brace is so made that the shank or back end of any bit will fit into it. The person using the brace puts the round part *a* against his breast,

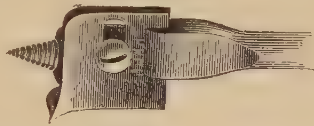


Fig. 3.—Bit with Movable Knife.

takes hold of the lower part *b* with the left hand, and turns the part *c* around with the right hand.

The word awl is from the Anglo-Saxon *æl*. Gimlet is from the old French *guimbelet*, which is from an old word meaning to twist. Auger is from the Anglo-Saxon *nafegar*, which is from *nafa*, the nave of a wheel, and *gar*, a spear or point; so that auger really means a nave-borer. Bit is probably from the Anglo-Saxon *bîtan*, to bite.

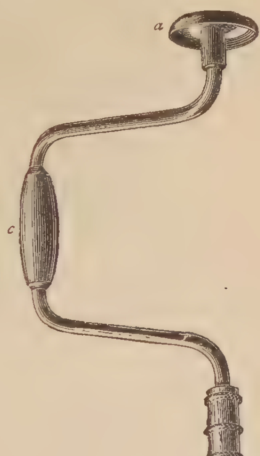


Fig. 4.—Brace or Bit-Stock.

AUGUST. See CALENDAR.

AUK, the name of sea-birds that live in the arctic regions. The largest, called the great auk or gare-

fowl, is now nearly extinct, being found only in Labrador and on some rocky islets near Iceland. It looks some like a penguin, its feet being at the end of its body so that it stands or sits erect. Its wings are unfit for flying, but they are used in the water to paddle with, and the auk will swim fast enough to escape from a six-oared row-boat. It builds its nest in caves and in crannies of rocks, and lays one large yellow egg, as big as a swan's, marked with black figures. The young are fed from the crops of their parents, even after they are able to take care of themselves.

The **Black-billed Auk**, or murre, lives on the northern coasts of America and on the coasts of Great

Great Auk.

Britain. The Esquimaux value it very highly, as it furnishes them food and clothing. It flies well, and uses its wings for swimming also, like the great auk.

The auk belongs to the order *natatores* or swimming BIRDS.

The word auk is from the Icelandic *alka*, auk.

AURORA BOREALIS, or northern lights, the bright clouds of light which are often seen in the northern sky in the night. *Aurora* is a Latin word meaning the light of the dawn of morning, and *borealis*, also Latin, means northern; and the two together means the northern morning-light, because it often looks like the daybreak in the east. It would be better to call it the polar light, because it is seen at the south pole as well as at the north pole. The

aurora is sometimes very beautiful, forming across the sky great arches of light through which flash bright streaks of red, blue, green, purple, and yellow flame. It is not known exactly what causes it, but it is supposed to be made by ELECTRICITY or lightning passing through bodies of air of different thicknesses.

AVALANCHE. See SNOW.

AX. The ax is one of the most ancient of tools, and it has been used

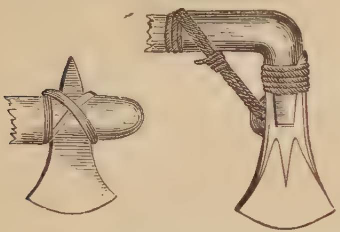


Fig. 1.—Ancient Bronze Axes.

by all peoples, civilized and savage. It differs from the adz in having an edge like a wedge, instead of like a chisel, and in having its handle set in a line with the edge instead of crosswise. Axes have long curved handles and are meant to be used with both hands. The handle of an ax, which in this country is made of hickory, is rightly called the helve,

Fig. 2.—Ax-head ready for the Steel Edge.

the thick metal part the head, and the hole for the handle the eye. In rude times axes were made out of a piece of flint or some other hard stone, ground down to a sharp edge. The handle was made by twisting a stick round the head in much the same way as is shown in the picture of the stone HAMMER. Stone hatchets called tomahawks were much used by the North American Indians, before they knew about iron, both for cutting wood and for fighting. Every Indian warrior carried one of these in his belt, and it was his principal weapon in hand-to-hand fights. Axes were

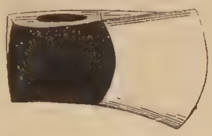


Fig. 3.—Yankee Ax.

also used in war by all ancient peoples, and many battle-axes of stone, bronze, and iron are to be seen in museums.

When people found out how to melt copper, axes were made out of that metal, and in time they learned how to mix a little tin with the copper and so to make BRONZE. Great numbers of copper and bronze axes have come down to us from old times, some of which are very well made and of good form. Two kinds

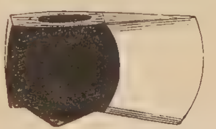


Fig. 4.—Kentucky Ax.

of bronze axes are shown in Fig. 1, in which it will be seen that the helves are fastened in different ways. Copper and bronze axes had been used for a long time before men found out how to make iron ones.

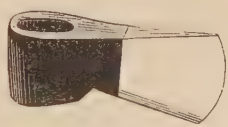


Fig. 5.—Brazil Ax.

The ax of modern times is made of hammered wrought-IRON, but its cutting edge is of STEEL. Such an ax is not only cheaper than one

made wholly of steel, but it is also better, for it is much stronger. An ax or hatchet made wholly of steel would be more apt to break, on account of the greater brittleness of steel.

In making an ax a piece of bar-iron is heated red hot, cut of the right length, and punched through by a

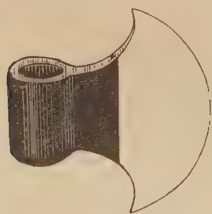


Fig. 6.—Ecuador Ax.

machine to make the eye. It is then heated again, pressed between DIES to give it the right shape, and grooved on the edge to make a place for the piece of steel which is to form the sharp edge. Its shape at this time is like that in Fig. 2.

The steel edge is put in while both parts are at a white heat, and the two are hammered together under a trip HAMMER, and drawn out till

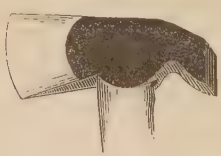


Fig. 7.—Cooper's Hatchet.

the edge is of the right shape. After being ground to a finer edge it is tempered by being heated and cooled quickly in water, and is then ground and polished. When finished it is stamped, and the head is blacked with a mixture of turpentine and ASPHALTUM to keep it from rusting, and then packed for sale.

The largest ax factory in the world is that of Collins & Co., at Collinsville, Conn. Axes and hatchets made there are sent to all parts of the world. They are so much better than the axes made in Europe that a great many false ones are manufactured, especially in Germany, and sold for true Collins axes. Different shaped axes are made for different countries. Two kinds are used in the United States: in the Northern States the Yankee ax, shown in Fig. 3, is used, but in

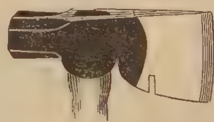


Fig. 8.—Lathing Hatchet.

most parts of the United States south of the Ohio River the Kentucky ax, shown in Fig. 4, is liked best. In the different countries of South America axes of many different shapes are used. Most of them have no heads, but have the eye close to the top, as shown in Fig. 5, which is the form used in Brazil, and in Fig. 6, which is the kind used in Ecuador.

The **Broad Ax,** which has a very wide blade, is used by ship carpen-

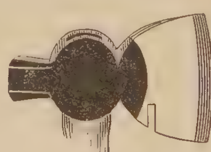


Fig. 9.—Shingling Hatchet.

ters for shaping the timbers of ships and by house carpenters, in places where sawed timber cannot be had, for hewing out the frames of houses.

A **Hatchet** is a little ax with a short handle, made to be used with one hand. There are many kinds made for different uses. In the pictures Fig. 7 is one used by coopers in making barrels and tubs; Fig. 8 is a lathing hatchet, for nailing laths on the inside walls of

buildings, to hold the plaster; and Fig. 9 is a shingling hatchet, for nailing shingles on to roofs. The slits in the heads of the last two are for drawing out nails.

The word ax is from the Anglo-Saxon word *eax*, which came from *axine*, the Greek name of the ax. Hatchet is from the French word *hachette*, little ax, a small form of *hache*, an ax, which is made from *hacher*, to chop.

B

BABOON, a kind of monkey with a very short tail, found mostly in Africa. Baboons are among the largest of the monkeys, and their strength is very great. They are ugly and fierce, cunning, and dangerous when attacked. Their fore and hind limbs are of nearly the same length, so that they run well on the ground; they are also good climbers and live a good part of the time in trees. Their food is mostly fruits, twigs, and roots, but they sometimes eat birds, lizards, and other small prey. There are several kinds, among which the pig-faced and the dog-faced baboons and the mandrill are the largest and fiercest.

The baboon is a MAMMAL of the order *quadrumana*, or four-handed animals, and of the same family with the MONKEY and APE.

The word baboon is in Old French *babouin*, but its origin is not known.

BACON, the cured sides of the hog. The thin parts of the ribs and belly make the best bacon. It is cured by rubbing into the flesh a mixture made of eight parts of salt and one part of saltpetre, every day for about three weeks, the meat being always kept in a cool place. Sometimes a little brown sugar is added to give it flavor. When the salting is done the bacon is either dried or smoked.

The word bacon is from the New Latin *baco*, meaning ham or salt pork.

BADGER, an animal about as large as a small pig, but fatter in the body and with very short legs and a long, sharp nose. It lives in Europe and in the northern parts of Asia and of North America, but not in South America. The American badger is yellowish-brown, marked sometimes with darker and sometimes with lighter colors, and with white stripes on the forehead, and its hair is long and coarse. It lives in burrows in the ground and feeds on roots, insects, birds' eggs, frogs, marmots, and other small animals. On the plains of the West it digs so many holes in following its prey that horses are often hurt by breaking through into them. It uses its nose and fore paws in digging, and pushes the earth back with its hind feet. Badger skins are sometimes used for covering soldiers' knapsacks and the pistol cases on their saddles, and the hair is made into shaving and paint brushes.

The badger is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the bear family.

The word badger comes from the old English *bageard*, which is probably from *badge*, referring to the way its forehead is marked.

BAGPIPE, a musical instrument much used by the Scotch Highlanders, and by country people in other parts of Europe. It is made up of a leather bag, which is blown full of wind by a tube leading from the player's mouth, and three or four pipes, one of which, called the chanter, has eight holes, and is handled somewhat like a flute; the others are called drones, and make the peculiar droning sound of the instrument. The player squeezes the wind-bag under his arm, which forces the air into the pipes. The bagpipe is a very ancient instrument, and was known to the Greeks and Romans. Pipers, dressed in High-

land costume, form a part of the Highland regiments in the British army.

BAIZE, a coarse woollen cloth, usually dyed green or red. Sometimes it has a long nap or furry surface on one side. It is used mostly for covering tables, screens, doors, etc.

The word baize is the plural of *bay*, meaning red or chestnut, and the cloth was probably so called because it was first made of a bay color.

BALLOON, a bag filled with a GAS lighter than air, so that it will rise and float in it. The gas used in balloons is usually HYDROGEN, which is about fourteen times lighter than air, or common coal gas, such as is burned for lights, which is two or three times lighter than air. Natural gas has been used also, with good results. The bag in which the gas is put is made of silk or of muslin, painted with india-rubber varnish so as to make it air-tight. A common balloon is about twice as high as it is wide, and shaped like a pear, and when filled with gas floats with the large end upward and the neck hanging down. The neck is always left open, because the upper air is thinner than that below, and the pressure being thus taken off the outside of the bag as the balloon goes higher, the gas inside swells so that it would burst it if it were closed. The bag is covered with a network of small rope, the ends of which come down below the neck, and are fastened to a hoop; and below the hoop, and hung from it by ropes, is the car, which is usually a wicker-work basket, though sometimes a boat is used on the chance of the balloon coming down in the water. The network strengthens the bag and makes the weight of the car and its load bear equally on all parts of its top. A long rope which hangs down through the neck of the bag within reach of the balloonist, who sits in the car, is fastened to a VALVE or little door on the inside of the top of the bag. When the balloonist sees that his balloon is going up too high, he pulls the rope; this opens the valve, and lets out some of the gas, and the balloon begins to come down again. When it has come down far enough, he lets go of the rope, and the valve closes so that no more gas can escape. Some bags of sand, called the ballast, are always carried in the car. If the balloon loses too much gas and goes down too low, it may easily be lightened by emptying the sand out of the bags. Every balloon has also a long rope with a hook on the end,

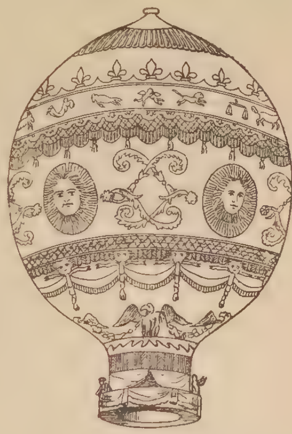


Fig. 1.—First Ascension in a Balloon.

called the grappling-iron, which is used to catch hold of something on the ground when the balloon is coming down, and to anchor it just as a ship is anchored to the bottom of the sea.

Balloonists sometimes carry up with them a kind of large umbrella called a parachute, which can be used in case of accident to the balloon. It is made very large and strong, and when opened wide is borne up by the air, so that the man, who sits in a small basket fastened to the handle, comes down to the earth quite easily and safely.

The first balloon ever sent up was made by Stephen Montgolfier, a paper manufacturer at Annonay, France, in June, 1783. It was nothing but a paper bag filled with hot air by burning straw and wool under its mouth. It rose about 2000 feet, was wafted about a mile, and came to earth again in fifteen minutes. In August of the same year M. Charles sent up one from Paris, made of thin silk varnished and filled with hydrogen gas. This went up 3000 feet, and in three-quarters of an hour fell about fifteen miles away. In September Montgolfier was invited to Paris by the king, and sent up at Versailles, in presence of the court, a balloon in the basket of which was a sheep, a cock, and a duck, all of which came down safely after reaching a height of 1500 feet. The first man to go up in a balloon was Pilâtre de Rozier, who ascended in a hot-air balloon, fastened by a rope, first about seventy feet, then about 200 feet, and lastly 300 feet, and was pulled down each time safely. Shortly afterward, November 21, 1873, he and the Marquis d'Arlandes ascended at Paris in a hot-air balloon (shown in Fig. 1), crossed the Seine and made a safe descent about five miles away. On December 1,

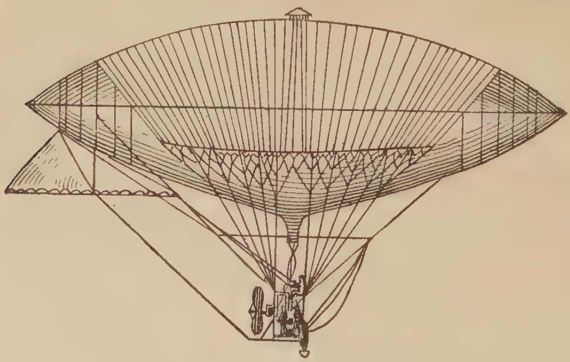


Fig. 2.—Tissandier's Balloon.

1783, two other men, Messrs. Charles and Robert, went up at Paris in a hydrogen balloon amid a great crowd of spectators, among whom was Benjamin Franklin, then American minister to France, rose 2000 feet and came down at Nesles, 27 miles away. Robert got out, but before Charles could follow the balloon shot up into the air again to a height of nearly two miles; but it finally came down safely three miles from Nesles.

The next person to go up in a balloon was an American. As soon as the news of Montgolfier's and Charles's balloons reached America, David Rittenhouse and Francis Hopkinson, friends of Franklin's, began to make experiments. They first sent up animals in a cage, and in May, 1784, James Wilcox went up in a cage fastened to 47 small balloons. In 1785 Dr. Jeffries, an American physician living in London, and Mr. Blanchard, a Frenchman, safely crossed the English Channel from Dover to France. In the same year Pilâtre de Rozier lost his life in trying the same feat. The first man to go up in a balloon was thus the first victim. Charles Green was the first to use coal gas instead of hydrogen. In 1828 he made an ascent on horseback. In 1859 John Wise went, with three companions, in a balloon from St. Louis to Jef-

ferson County, New York, 1150 miles, in twenty hours. James Glaisher made many ascents, the most remarkable of which was on September 5, 1862, at Wolverhampton, England, in company with Mr. Coxwell, when he went up seven miles, higher than anyone had ever been before.

Ever since balloons were invented experiments have been made to find out some way to steer them. Oars, fans, rudders, sails, and various other devices have been tried, but none with much success. In 1852 Giffard, a Frenchman, went up 5000 feet in a balloon worked by a steam engine, and partly succeeded in steering his machine, which was not like an ordinary balloon, but low and wide. In 1872 Depuy de Lome went up in a similar balloon with a boat suspended under it, in which were a dozen men who turned the propeller by a crank, but it worked no better than Giffard's. In the same year a German named Hänlein ascended in a balloon propelled by a gas engine, and is said to have gone ten to twenty miles an hour. In 1883 Gaston Tissandier, a pupil of Giffard's, ascended in a balloon shaped much like de Lome's (Fig. 2), but driven by an electric engine, and succeeded in making it go slowly against the wind. Messrs. Renard and Krebs, officers of the French army, made an ascent in 1884 in a long, cigar-shaped balloon (Fig. 3), driven by electricity, steered it in several directions, and descended to the same place from which they started. In 1888 Peter C. Campbell of Brooklyn, N. Y., made a balloon propelled by clock-work, in which James Allen made a successful ascent, steering it against the wind and in several directions for two hours, when he came down at the point he started from. In 1889 E. D. Hogan made another ascent with this balloon, but his propeller did not work and he was carried out into the Atlantic, and lost with his balloon.

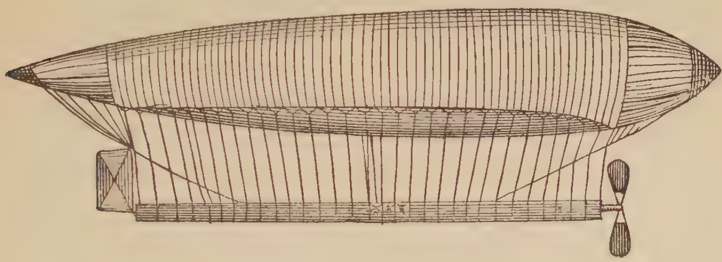


Fig. 3.—Renard and Krebs' Balloon.

Though all attempts to navigate the air have thus far been almost failures, men are still working at the problem, and many believe that balloons will some day sail the air as easily as ships do the ocean.

Captive Balloons. Balloons made fast to a rope are used both on battle-fields to watch the movements of the enemy's troops, and on naval vessels to spy out the manœuvres of hostile ships or the exact position of a fort or town to be attacked. The men in the basket are connected with the ground or the ship by a telephone, so that they can tell those below what they see. The French used a balloon thus at the battle of Solferino (1859), and found it very useful in spying out the Austrian positions. They have now a corps of trained balloonists in both their army and their navy. Balloons were used also in our Civil War in the battles around Richmond.

More than sixty balloons were sent

out of Paris at different times during its siege by the Germans (1870–71). Several of these fell within the German lines, and were seized by the enemy, but most of them came down safely, though some were carried by the wind a great way from the city. One fell in the middle of Norway. Three were never heard from, and are supposed to have been swept out into the ocean. Almost all the letters sent from Paris during the siege were carried out in this way, and carrier PIGEONS were usually taken along to send back answers.

Toy balloons made of tissue paper are in principle much like Montgolfier's balloon. They are easily made by cutting the paper into pieces nearly like quarters of orange peel, and pasting the edges together. The bottom, which is left open, should be pasted over a hoop of very light wood or of wire, and a wire should be stretched across the middle of it to hold a sponge wet with turpentine or alcohol. When this is lighted the air inside will soon get heated enough to cause the balloon to rise; and if the balloon go up with the sponge burning it will stay up much longer, because the air will keep heated longer.

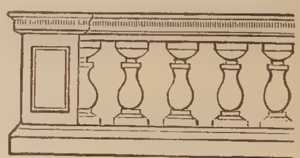
The word balloon comes from the French *ballon*, a ball; and the balloon was so named because the first ones made were round.

BALTIMORE BIRD, an American bird, often wrongly called Baltimore oriole; but there are no orioles in America. It is sometimes called also hang-bird, fire hang-bird, and golden robin. It is found all over the United States, coming North in summer and going South again in the autumn. The male birds are very beautiful, the head, neck, wings, and tail being black, and the under parts and back bright orange, with a tinge of vermilion on the breast. The colors of the females are duller than those of the males, and they are a little smaller. The nests of these birds are hung from the end of a shady branch by a network of strings, and are very neatly and skilfully made. Baltimore birds lay five or six light-brown eggs, spotted with darker brown. Their food is mostly insects.

The Baltimore bird belongs to the order *insessores*, or perching BIRDS, and to the starling family.

It is so called because its colors, orange and black, are like those of the livery of Lord Baltimore.

BALUSTER, a small column or pillar for supporting the rail of a staircase, balcony, etc. It is sometimes wrongly called *banister* and *ballaster*. Balusters are usually made of wood, stone, or metal. Wooden ones are turned in a LATHE, stone ones are generally cut with chisels, and metal ones are cast. A row of balusters with the rail and other parts by which they are held together,



Balustrade.

is called a balustrade. Balustrades are used to enclose stairs, balconies, chancels, terraces, and the tops of buildings. In the balustrade of a staircase the large post at the foot is called the newel, or newel-post.

The word baluster comes from the Latin *balaustium*, Greek *balaustion*, the flower of the wild pomegranate, either because balusters were shaped like that flower or were ornamented with it.

BAMBOO, a kind of reed growing in Asia and in the West Indies. It is really a GRASS, but it grows as large as some trees, being usually forty or fifty feet high, or as tall as a pretty high house. Its stems are from one to eight inches thick and jointed. The Chinese, who use bamboos more than any other people,

plant shoots of the tree in large plantations, and after four or five years the reeds or canes are ready to cut. The bamboo does not blossom until it is about thirty years old, and dies after it goes to seed. The Chinese eat the seeds like rice and the tender shoots like asparagus; they make the shoots also into pickles and preserves. Almost everything is made from bamboo—houses, fences, boats, water-buckets, bottles, furniture, umbrellas, canes, fans, hats, paper, water-pipes, baskets, cages, bows and arrows, pens, and handles for tools and weapons. Some cities in the East are entirely built of bamboos.

A kind of bamboo with a square stem grows in Japan and in China. It is cultivated chiefly for ornament, especially in temple courts and gardens, and is thought to have miraculous powers. The Chinese say that it began with a miracle—that the famous alchemist, Ko-Hung, had a pair of square chopsticks which he thrust into the earth in the temple garden at Ningpo, and that they took root and grew into a new kind of bamboo. The stems of the square bamboo seldom grow more than ten or twelve feet high and are about an inch and a half thick.

The word bamboo is from *bambû*, the Malay name of this plant.

BANANA, the fruit of a plant growing in hot climates, which belongs to the same family with the plantain. The plantain and the banana were once thought to be different fruits, but they are now generally thought to be only different kinds of the same fruit. Plantains are coarser than bananas and are used mostly for cooking, while bananas are usually eaten raw, though they are sometimes made into puddings and pies, or fried like oysters.

The banana plant is really a kind of herb, the stem of which is made up by the union of the leaves as they grow. The leaves, which are sometimes as long as a man, are of a beautiful emerald green. The fruit grows in great bunches, which often weigh a hundred pounds each. When ripe the skin is yellow, but the bunches are usually picked when green and hung up in a cool place. All those sold in the United States are picked green and ripen on the vessel or after they get here. One kind of banana, brought from the West Indies, has a bright red skin when ripe.

The banana is one of the most important of foods in hot countries.

Banana Plant with Fruit.

A piece of ground of a size to grow wheat enough to feed one man will, if planted with bananas, make food enough to feed twenty-five men. A plantation will bear all the year round. When green this fruit contains much starch, which on ripening changes into sugar. When unripe it is often dried in the sun and made into flour. The young shoots of the plant are eaten as greens, and a kind of grass cloth of great beauty is made from the thready part of the leaves.

The banana is said by some to have been cultivated in Mexico before the Spaniards came, but this is doubtful. It probably grew first in Southern Asia and was carried from the Canary Islands to the West Indies and other parts of America by the Spaniards.

The word banana is the Spanish name for the fruit of the *banano*, the banana tree.

BANDANNA, a kind of handkerchief, dyed usually red, yellow, or blue, and having on it round or diamond-shaped white spots. The cloth is first dyed of the color wanted. A pile of the handkerchiefs is then put into a press between two copper plates, one of which is fastened to the bottom and one to the top of the press. These plates are pierced with holes just like the spots that are to be made on the handkerchiefs. A great pressure is now put on the pile and a bleaching liquid called CHLORINE is made to flow over the top plate. The liquid goes down into the holes, passes through the cloth, and comes out of the holes in the bottom plate, taking out all the color and making white spots just the size and shape of the holes in the plates. The pressure is so great that the liquid can reach the cloth only where the holes are.

The word bandanna is probably from the Hindu *bāndhnū*, meaning a way of dyeing in which the cloth is tied with a cord (*bāndh*) so that some parts will not get the dye.

BANJO, a stringed musical instrument, played with the fingers. The neck and the head of the banjo are somewhat like those of the guitar, but the body is round and covered with PARCHMENT like a drum-head, instead of with thin wood as in the guitar. It usually has five strings. The banjo is much played by negro minstrels and by negroes in most of the Southern States, though Joel Chandler Harris says it is unknown on Georgia plantations.

The word banjo is made from *bandore*, Spanish *bandurria*, the name of a kind of guitar.

BANK. Every child old enough to read and write ought to keep a bank account with his father, or some other grown-up person, for he will thus learn something about taking care of money and doing business. Money carried about in the pocket or kept in a cash box or drawer is apt to be stolen or lost, so business men put what they do not want to use into a bank. When a person leaves money in a bank it is put to his credit, that is, it is set down under his name on the books of the bank. If he wants his money again, or a part of it, he draws a check for the sum needed, and hands it to the proper officer in the bank. The sum named in the check is given to him, and the bank officer takes it from the sum to his credit on the books.

When a child keeps a bank account with his father, he gives him all the money he wishes to keep, and the father keeps an account of it just as the bank does for the business man. The child also should have a little book in which his father can set down on one side all the money he gets from him, and on the other all he pays back to him. He will thus know all the time exactly how much money he has in bank. When he wants any money he should draw a check and give it, just as the business man does.

The following is the form of a check:

No. 20. NEW YORK, July 1, 1893.
National Park Bank.
Pay to John Doe, or bearer,
One and $\frac{50}{100}$ Dollars.
$1.50 JOHN DOE.

Such a check is called a check payable to bearer, because any person who has it can get the money for it; but if it were written "to John Doe, or order," no one could get the money but John Doe, unless it were indorsed by John Doe. To indorse a check means to write one's

name across the back of it, the word being made from the Latin *in*, on, and *dorsum*, the back. A check payable to bearer is mostly used when a person draws money from a bank, and one payable to order when a person pays out a check to some other person whom he owes, thus using it for money.

Checks payable to order are usually drawn as follows:

No. 16. NEW YORK, Oct. 7, 1893.
National Park Bank.
Pay to the order of Richard Roe, Three and $\frac{19}{100}$ Dollars.
$3.19 JOHN DOE.

Such a check is an order on the bank to pay the money to Richard Roe, who would have to indorse it before he could make use of it. A child who keeps a bank account with his parent would generally use only a check payable to bearer, but he ought to know about both kinds. When he gives a check to his parent he will at the same time give him his book, and the sum named in the check will be taken from the account of money paid in, and set down under that paid out.

The use of checks saves business men much trouble; indeed, business could hardly be done without them. When a merchant wishes to send money to a distance, he does not send gold or bills, but a check in which the bank where he keeps his money is ordered to pay the sum named in it to the person to whose order it is made. That person writes his name across the back of it, and puts it into his own bank, where it is put to his credit; and this bank gets the money from the bank named in the check.

To understand about banks we must first look a little into their history. The first bankers in England were Italian Jews from Lombardy. Lombard Street, the principal banking street in London, was named after them. They were called bankers because they first had benches or *bancos* (Italian *banco*, bench) in the market place, where they exchanged small pieces of money for large. After a time they began to take care of money for people who had no safe place to keep it in, and to lend money to those who needed it. When a banker lent money he made the borrower leave with him goods, jewels, title deeds to land, and other valuable things which were worth more than the money lent, so that if the borrower failed to pay the money, the banker could get it back by selling the things left with him. If the borrower paid the money at the time named, and gave the banker a small sum besides to pay him for the use of it, he got back his property. The property thus held for borrowed money was called security (Latin *securitas*, safety), because it made it safe, and the sum paid for the use of money, interest (Latin *interest*, it is of benefit), because the banker got that much benefit for the loan of his money.

There are now three kinds of banks—banks of deposit, banks of discount, and banks of circulation.

A **Bank of Deposit** is one which receives and takes care of money, and pays it out for checks.

A **Bank of Discount** is one which lends money on security, just as the old bankers used to do. But banks do not now take goods, jewels, and such things as security; that is done only by pawnbrokers. When a person wishes to borrow money from a bank, he usually makes his note for the sum wanted. A note is a written promise to pay a sum of money at a time and place named in it.

The following is a common form:

$125.50.
NEW YORK, August 1, 1893.
Sixty days after date, for value received, I promise to pay to the order of Richard Roe, One Hundred and Twenty-five and $\frac{50}{100}$ dollars, at the National Park Bank.
JOHN DOE.

The person who makes or signs the note is called the maker, and the one to whose order it is made the payee. The person who owns a note is called the holder. A note written like the above, or if written, "to Richard Roe, or order," or "to Richard Roe, or bearer," is negotiable, that is, it may be used as money. If written to "order" as in the first two cases, Richard Roe would have to indorse it by writing his name across the back; but if to "bearer," it may be paid out without indorsing. There are two kinds of indorsements. If the payee merely writes his name across the back, it is called a blank indorsement, and it may then be paid out like a note to bearer. But the payee may direct to whom the note shall be paid, and he then writes on the back: "Pay to the order of ——," writing in the name of the person to whom he wishes it paid, and signs his name below it. This is called a special indorsement; the person to whom it is indorsed is called the indorsee and the person indorsing the indorser. The indorsee can indorse to a second indorsee, and so on to any number. In indorsing a note, the indorser promises to pay the note when the time named in it comes if the maker fails to do so. The bank which lends money for the note thus has a double security for its payment.

Banks always charge a little interest for money loaned. This interest is taken out when the money is lent, and only the remainder is paid to the borrower. For instance, if the note is for $100, and the time named in it for the repayment of the money is one year, the bank will take out $6, if the rate of interest is 6 per cent. (Latin *per*, by, and *centum*, hundred, meaning $6 on each $100), and will pay the borrower only $94; and at the end of the year the borrower will have to pay the $100 in full to the bank, thus returning the money which he received and the interest added. Interest is thus the sum which the bank gets for the use of its money. Interest is usually 6 per cent., but in some States it is 7 per cent., and in a few States still more.

All banks of deposit are now banks of discount also. If a banker acted merely as a keeper of people's money he would get no profit from it; he therefore loans it out on interest, and thus gets paid for his trouble. The money lent out by banks does a great deal of good. If it were hoarded up in vaults and safes it would be of no use to anybody, but when put into public use it goes all through the country and makes business prosperous. Banks lend not only the money of others, but also their own money. Their own money is called their capital. A bank without capital would not have the confidence of the people, and would get no deposits, because if it lost any of the money which it loaned out it would have no means of repaying it.

A **Bank of Circulation** or issue is one which pays out its own notes for money. A bank-note is not money; it is only a promise to pay money; but when people have full faith that the promise will be kept, it passes just the same as money. The promise is usually to pay the amount of the note to the bearer of it, on demand, in gold coin. Banks of deposit and discount are usually also banks of circulation; but there are some which do not pay out their own notes.

A **Savings Bank** is a bank of deposit which receives and takes care of money, and gives interest for the use of it. Such banks are used chiefly by poor people, who can thus lay up small sums of money in a safe place, where it will all the time be gaining interest. The bank lends this money to other people on good security, for a larger interest than that which it pays, and thus makes money for itself. Such banks are not allowed to lend money simply on indorsed notes, like banks of discount, but are obliged by law to have

good security, such as bonds, land, etc., which will sell for more than the money loaned.

BANK-NOTE. In no other country in the world are bank-notes made with so much skill as in the United States. Every bank-note in this country is a fine engraving, printed from a steel plate. The making of the plate is a long and difficult work, which takes the labor of many persons. Each one is made up of several parts. Take, for instance, a five-dollar United States note: in the middle is a picture, with the words "UNITED STATES" and "FIVE DOLLARS," a part on each side of it; on the left is a small portrait, called a vignette; and in each of the two upper corners is a black space covered with a network of fine white lines,

Bank Note Counter.

the one on the left with a V on it, and the one on the right with a figure 5 on it. These network spaces, which are called "counters" are somewhat like the one shown in the picture.

These different parts of the note are made separately and on separate plates. In making a vignette, a large drawing is first made with the greatest care on paper. A daguerreotype is then taken of this of exactly the size of the engraving wanted. The engraver marks with a steel point on the daguerreotype plate all the outlines of the picture. A print is taken from this plate, just as from a steel plate (see ENGRAVING), and while the ink is still damp the paper is laid face downward on a steel plate, which has been softened by heating it red-hot and then letting it cool slowly, and pressed in a press. An exact copy of the outline is thus printed on the plate, and the engraver then finishes the vignette with the burin, like any other steel engraving, excepting that nothing but line engraving is put on a bank-note plate.

This plate is never used to print from, but only for making other plates. It is first hardened, by heating it and cooling it quickly. A little roller of softened steel, just as wide as the engraving, is then rolled over the plate by a very powerful machine until its soft surface has been forced into all the lines cut into the plate. This makes a relief of the engraving—that is, the lines which in the plate are all sunk below its surface appear on the roller in relief, or above the surface. The roller is then hardened and may be used to roll over other plates, in each of which the lines will thus be sunk exactly like those in the first or engraved one. This is called the transferring process, because the original engraving is transferred or changed to other plates.

The picture in the middle is also engraved and transferred to a softened roller like the vignette; but the counters are made in a different way, by a machine named a lathe. All the network designs on the back of the note are also made by the lathe. They are so perfect that they cannot be made by hand, and it is almost impossible for counterfeiters to get one of these machines, which cost about $5000 apiece. After the counter has been engraved by the machine on softened steel, the figure is engraved by hand in the middle, and it is then hardened and transferred to a cylinder just like the others.

The plate from which the bills are to be printed is of softened steel, and is large enough to print four bills at once; so four engravings of the note are made on it. If all these had to be engraved by hand it would take a long time, and all would differ a

little from each other; but when made by the transferring process they are done quickly and all are exactly alike. For instance, in making the plate of the five-dollar bill the little steel roller having the raised picture on it is rolled backward and forward over the middle of the four plates until the picture is pressed into each one. The vignette is next rolled on in the same way in its proper place in each of the plates, and the other parts one after the other. After all the parts have been rolled on, the plate is finished by the hand engraver, who engraves on it all the lettering excepting the fine lettering around the border, which is made by a machine and transferred to the plate like the pictures.

Bank-notes are printed on very fine and carefully made paper. The paper of each note has two fine blue silk threads running through it a little more than an inch apart, which are put in when the paper is made. They are so fine sometimes as to be scarcely visible, but they are in every bill issued by the government, to make it more difficult to be copied by counterfeiters. Bank-notes are printed like any other steel engraving. All the black part is printed first. After the note is dry the green back is printed on it, and when that is dry the red stamps are put on and the note is signed. To make sure that none of the money be stolen, one part of the note is usually engraved and printed at one place, and another part at another place, and then the note is sent to Washington to be finished and signed.

BANYAN TREE, a very large kind of fig tree growing in the East Indies and in Ceylon. When the trunk has grown about fifty feet high it throws out many branches, each of which sprouts and sends down roots like ropes that finally reach the ground, fasten themselves, and grow into new trunks, which in time have branches like the parent trunk. The tree thus spreads over a very large surface, often covering many acres. One that stood on the bank of the Nerbudda in India, supposed to be the tree described by Nearchus, the admiral of Alexander the Great, is said to have been large enough to shelter 7000 men, and others cover twelve or thirteen acres, or about 220 city lots. The leaves, which are bright green and about five inches long by four wide, are used in India for plates and dishes. The bark is made into cordage and used for medicine, and its white gum is thought to be a cure for toothache and for bruised feet. It is made also into birdlime. The fruit, which is bright red, is about as large as a cherry and insipid in taste. The birds like it and drop the seeds in crevices of buildings or on trees, and when they take root they grow rapidly and widen the cracks and sometimes kill the trees. The poet Southey describes the banyan tree in "The Curse of Kehama." A large one is growing at Nassau, New Providence, and others may be seen near Lake Worth in Southern Florida.

Banyan tree means the tree of the banyans or Hindu merchants.

BARBERRY, a shrub which grows wild in the northern parts of Europe and Asia, and in many parts of the United States. Its berries, which are about the shape and size of grains of wheat, and bright red, are so sour that birds will not eat them; but they make a pleasant drink, and good preserves and jelly. A fine yellow dye for leather is made from its bark and roots, and its bark is used also for tanning.

The word barberry comes from *berberis*, the Spanish name of the plant.

BARIUM, a METAL, one of the ELEMENTS. It is never found as a metal, but always mixed with other things, such as OXYGEN and SULPHUR. The chemist sometimes makes a little of the metal, but not enough for much use. The compounds of barium with other things

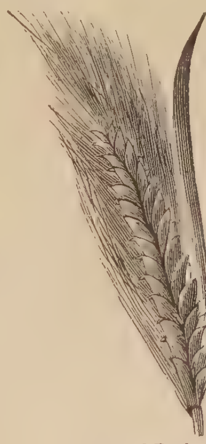
are used in medicine and the arts. Baryta or barytes (barium oxide), made up of barium and oxygen, is a poisonous earth, used by chemists; but what is commonly called baryta or barytes is the sulphate of baryta (barium sulphate), which has sulphur in it. This is a heavy white mineral, called also heavy spar, which, when ground fine, is much used to mix with white lead. It is also put into paper pulp to make paper weigh more and to give it a gloss. White satin paper is made with it.

The word barium comes from the Greek *barus*, heavy, and the metal gets its name from its great weight.

BARK the rind or skin of PLANTS. The bark of trees is usually made up of two parts, an outer and an inner bark. The outer bark is only a covering to protect the inner one, and has no life in it. In many kinds of trees it is coarse and rough, and it often breaks off in pieces as the tree grows. The whole outer bark of the white birch tree may be easily peeled off. The inner bark, which lies between the outer rind and the wood, is always fresh and full of sap when the tree is alive, and is the cause of its growth. The sap, which goes up through the wood of the tree from the roots to all the branches and leaves, comes down again through the inner bark and makes new wood and new bark grow every year. If the sap did not thus go down through the bark, the tree would die. You can now see why a tree is killed when it is girdled by cutting a strip of the bark off all around it. The bark of some trees is very thin, and of others very thick, such as that of the great trees of California, which is sometimes two feet thick. Bark has many uses: many kinds are used in dyeing and in tanning leather, and corks are cut from a kind of oak bark; the Indians make canoes and huts out of it, the South Sea Islanders cloth, and many peoples paper, baskets, ropes, and twine. The inner bark of some trees, especially the LINDEN, is called bast. Cinnamon is the bark of a tree that grows in Ceylon, and quinine is made from Peruvian bark.

The word bark is from the Danish or Swedish, both of which languages have the same word.

BARLEY, a kind of grain. It is not known in what country barley first grew, but it has been raised by almost all peoples from the most ancient times. It grows in climates too cold for other grains, and is also raised in warm climates. Barley is good food for cattle, and in the northern parts of Europe it is ground



Head of Barley.

and made into a coarse kind of bread, but it is mostly used in making BEER. In Scotland it is made into barley broth. The grains of barley, called barley corns, are yellowish-brown on the outside and white on the inside. When stripped of the outer husk and rounded in a mill, they look like little pearl-white shot, and are called pearl barley. Pearl barley cooked and mixed with milk is among the best foods for babies.

The word barley is from the old English *bærlic*, which is from the Anglo-Saxon *bere*.

BARNACLE, a kind of shell-fish that fastens itself to rocks and other things under water and to the bottoms of vessels, by which many are carried to all parts of the world. They live in all seas, arctic as well as tropic. Some, too, fasten to the skins of sharks and whales and on the backs of turtles, and some are found in sponges. The bodies of barnacles are enclosed in shells, generally white or purplish-blue; and they have a long neck or stem by which they attach themselves to objects. Their food is small crustaceans and mollusks, which get entangled in little threads that the barnacle is continually throwing out and drawing in, thus serving as a

Barnacle.

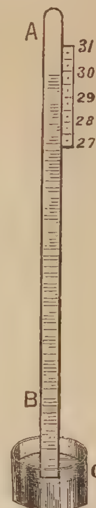
kind of net. The ancients used to like barnacles and the Chinese still eat them. They do no harm except to vessels, especially those not covered with copper, to whose bottoms they sometimes fasten themselves so thickly as to impede their sailing.

In old times people thought that barnacles underwent all sorts of changes, and some believed that they even turned into geese, which were called from them Barnacle Geese. The barnacles were said to grow on trees in the Orchades Islands in the North of Scotland; that in time they opened and let the legs hang out; that the bird grew larger and larger, until at length it hung only by the bill and soon after dropped into the water, "where it gathereth feathers and groweth to a fowle bigger than a mallard and lesser than a goose;" but those "that do fall upon the lande perish and come to nothing."

The barnacle belongs to the CRUSTACEAN class of the *articulata* or jointed ANIMALS.

The word barnacle is *bernache* in French and Spanish, but its origin is not known.

BAROMETER, an instrument to measure the weight of the AIR. If you put one end of a tube into a bowl of water, and the other end into your mouth, you can draw the water up through the tube into your mouth by sucking. You may think that you suck the water up, but you do not; you only suck the air out of the tube, and the weight of the outer AIR, pressing down on the water in the bowl, forces it up into the tube. As soon as you let the air into the tube again the water runs back into the bowl. If you had a tube long enough and you could suck all the air out of it, the water would rise up in the tube nearly thirty-four feet. It would stop at this height, because the weight of a column of that height just balances the weight of the air which presses down on the surface of the bowl. If the tube is more than thirty-four feet long there will be above the water a space in which there will not be anything, not even air. This is called a vacuum (Latin, empty space). If you should put the tube into some fluid lighter than water, the fluid would rise higher in the tube than thirty-four feet, because it would take more of it to balance



Straight-Tube Barometer.

the weight of the air; and if the fluid were heavier than water it would not rise so high, because it would take less of it to balance the weight of the air.

More than two hundred years ago (1643) an Italian named Torricelli, who knew that water would rise up in a tube about thirty-four feet when the air was drawn out, but did not know why, tried to find out the reason of it. He filled a glass tube thirty-three inches long, and open at only one end, with MERCURY, and then putting his finger over it so as to keep the mercury in, he turned it bottom upward into a bowl of mercury, and then took away his finger. As mercury is one of the heaviest things in the world, it would seem as if it ought to have all run out of the tube into the bowl; but it only fell a little way, and remained there standing in the tube. As mercury is about fourteen times heavier than water, Torricelli saw that the height of the mercury in the tube was about one-fourteenth part of that of the thirty-four foot column of water, and he at once concluded that both the mercury and the water were held up by the pressure of the air on the surface of the bowl. He afterward found out that the mercury did not always stand at the same height, but that it would rise and fall with the changes in the weather.

This led to the making of the barometer, which is the same in principle as the tube used by Torricelli. In the picture, A B is the tube, and C the dish of mercury. The space above the mercury is called the Torricellian vacuum, because Torricelli first found it out. A scale of figures is put on the side of the tube, so that as the mercury rises or falls the pressure of the air can easily be seen. Such a barometer is called a straight-tube barometer, but the one most used has a bent tube, like that in the second picture. In this the tube, A B C, is bent like a SIPHON, but it works the same as the other, because the air presses down on the mercury through the open end of the shorter tube with just as much force as it does on the surface of the bowl. This is called a siphon barometer. A little weight, D, rests on the top of the mercury in the open end, and rises and falls with it. It is fastened to a thread which passes out of the tube and around a wheel which moves a pointer, F, like a clock hand. This pointer turns round a dial, G, and points to figures showing the height of the mercury and also to words such as "Fair," "Rain," "Changeable," etc. In pleasant weather, when the air is dry and free from dampness, it is heavier than in wet weather, and the mercury rises in the longer tube, causing the little weight to fall and move the pointer round till it points to the word "Fair," or some place near it.

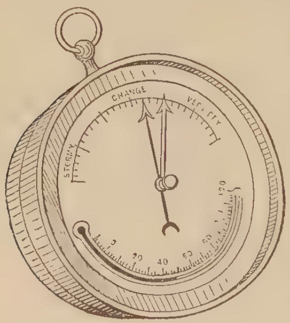
Siphon Barometer.

When the air is moist it is lighter than when it is dry, and the pressure being partly taken off from the weight, it rises and the mercury in the longer tube falls. This moves the pointer round the other way, and it then points to "Stormy" or "Rain."

The barometer is often used to tell the height of mountains and other high places. As the air gets thinner the higher we go, the pressure becomes less and less on the mercury in the open end of the tube and causes that in the long tube to fall. As we know about how much the mercury will fall in going up a hundred feet, we can tell very nearly the height of a mountain by noticing the height of

the barometer at the bottom and then at the top.

The **Aneroid Barometer,** the one most commonly used now, is a barometer without any fluid in it. It is a round, metallic, air-tight vacuum case, somewhat like a watch, the lid of which, held by metallic springs inside, rises and falls by the pressure of the atmosphere. By some simple machinery this rise and fall is made to turn the pointers on the index and thus show the change. This barometer, which is fitted with a thermometer, as shown in the picture, is very useful to travellers, who can tell from it the height of mountains and other lofty places almost as accurately as if they measured them.



Aneroid Barometer.

The word barometer is made up of the Greek words *baros*, weight, and *metron*, measure. Aneroid is from the Greek *a* without, *neros*, liquid, and *eidos*, form, a form without fluid.

BARREL. The sides of a barrel are made up of narrow pieces, called staves, which are made wider in the middle than at the ends, but are bent so that their edges fit tightly together. This forms what is called the bulge of the barrel—that is, the swell of the middle—and adds greatly to its strength. A barrel made with staves of the same width from end to end would be straight instead of bulging, and would be much more easily broken in from the outside, for the bulge acts like an ARCH and resists pressure.

The staves are held together by hoops, which are sometimes of wood and sometimes of iron. Grooves are cut around the inside of the staves near each end to receive the heads, which are round, flat pieces of wood, shaved thin at the edges so as to fit into these grooves. Heads are usually made of two or more pieces, fastened together at the edges by wooden pins called DOWELS. When they are put into place the last hoops are put on and driven down tight, which brings the ends of the staves closely together and causes the grooves to hold the heads firmly. The ends of the staves which reach beyond the heads are called the chines.

Barrels made for liquids usually have a large round hole, called a bung, in the middle of the side, by which thay may be filled and the contents may be drawn off. Barrels for dry articles are always unheaded by removing the hoops at one end, when the head readily comes out. The barrel is much more convenient to handle than the square box. It can be quickly rolled from place to place, and is swung in and out of vessels by means of hooks caught under the chines. Barrels were once always made by hand, but most of them are now made by machinery. The staves are planed, bent, and grooved in a machine, and come out all ready to be made up into barrels. The wood most commonly used for staves is oak, though much elm is used for flour barrels. The hoops and heads of flour barrels are generally of ash. Wine and beer barrels are usually of oak with iron hoops. Barrels are sometimes made out of paper. Different sizes of barrels are called kegs, casks, pipes, hogsheads, and butts.

The word barrel is from the French *baril*, but its origin is unknown.

BASALT, a very tough, heavy, igneous ROCK, usually dirty-brown, greenish-black, or black. It is often found in regular jointed columns, as in Fingal's Cave, Scotland, the Giant's Causeway, Ireland, and on the shore of Lake Superior. Basalt is much used, on account of its hardness, for macadamizing roads and making pavements. It is sometimes also melted and cast into blocks for building and mouldings.

The word basalt is from the Latin *basaltes*, a dark, hard kind of marble found in Ethiopia.

BASES, a class of substances which, when mixed with ACIDS, unite with them and form compounds (see ELEMENT) called SALTS. Bases, like acids, are made up usually of the elements HYDROGEN, OXYGEN, and some one other element; but, while in acids this third element is something which is not a metal, such as NITROGEN, SULPHUR, and CARBON, in bases the element which unites with hydrogen and oxygen is usually a metal, such as POTASSIUM, SODIUM, and COPPER. For instance, nitric acid is formed by the union of hydrogen and oxygen with nitrogen, which is not a metal; and the base caustic potash is formed by the union of hydrogen and oxygen with potassium, which is a metal. Thus we have two classes of substances, one called acids and the other bases, which are wholly different from each other. If now we mix one of these acids with a base, the two will unite and form a substance entirely different from either. Thus, nitric acid and the base caustic potash will unite when brought together, and form nitre or SALTPETRE (potassium nitrate), which is not like either nitric acid or potash. The compounds made by the union of acids and bases are called salts, because they have a general likeness to common SALT, which was one of the first salts known. A certain class of bases are called ALKALIES.

The name base, which comes from the Latin *basis*, foundation, is given to this class of substances because they are the foundation of compounds.

BASKET. The weaving of wicker-work is one of the oldest arts known to man. Baskets made before the time of Christ have been found in Egyptian tombs. The ancient Assyrians were skilful in wicker-work, and even made boats of it for use on the river Tigris; and the same kind of boats are still used on that river. These boats, which the Arabs call *gooffah*, are merely large, round, flat-bottomed baskets, made of strong wicker-work. They are made water-tight by a coat of ASPHALT, smeared about an inch thick all over the inside and outside. This, which is mixed with some other things, soon becomes as hard as stone. Some gooffahs are large enough to hold as many as twenty persons at once, and camels, horses, cattle, and sheep are often carried across the river in them. The Romans found the same kind of boats in use among the Britons. The Britons also built huts of wicker-work, and made great cages out of it in which they shut up and burned alive their prisoners of war. Indeed, so skilful were they in this kind of work that baskets made by them were much sought after and brought high prices in Rome.

Many kinds of twigs and splints are now woven into baskets, but the shoots of the WILLOW, or osier, are most generally used. These, which are cut yearly, are first soaked in water, and then peeled by a tool made for the purpose. They are sometimes used whole and round, but for fine work they are split into flat strips, like the straw used in plaiting straw hats and bonnets. Ash, elm, and birch shoots and splints are also used in basket-making. Splints are thin flat strips got by beating logs of wood with a maul or mallet until the layers of wood separate from each other, when they are peeled off and cut into the proper widths. There are now several

machines for making splints, which cut the wood from the log into the right thickness. Strong baskets are woven from rattan canes used either whole or split, and much furniture also is now made from them.

Basket-making is very simple. Strong pieces are first laid across each other and woven together to make the bottom; the ends of thinner pieces are then fixed in these and turned up to form the ribs, and the sides are made by knitting or weaving smaller rods in with these until the basket is high enough, when the ribs are turned down and woven in so as to hold the whole tightly together. This is the way to make the rudest kind of basket. Fine baskets are woven in many different patterns and colors, the splints being colored before using. The most elegant baskets are made in France, China, and Japan. In South America the Indians make baskets of rushes so closely woven that they will hold water; and the North American Indians also make very pretty ornamented baskets.

The origin of the word basket is unknown.

BASS. Fish of this name are found in almost all parts of the world, some in fresh and some in salt water. The principal fresh-water kinds in the United States are the black bass and the rock bass.

The **Black Bass** is found in most of the Western lakes and streams, and many have been put into lakes in New York and New England. It is blue-black above with bronze shadings, and lighter below. This fish sometimes weighs seven or eight pounds. It bites well and fishing for it is good sport. The best bait is the minnow or other small live fish.

The **Rock Bass** is broad like a roach, and is coppery-yellow in color, with dark bands and marks. It seldom weighs more than a pound, but makes good fishing, and is much liked for the table. It was once common only in the streams of the valley of the St. Lawrence, but many are now caught in the Hudson River. Other fresh-water bass, such as the white bass and the grass bass, are caught in the great lakes.

The **Sea Bass,** sometimes called the black bass, is the most important of the salt-water bass of the United States. It never goes into fresh water. Its color is blue-black above and lighter below, and the scales are edged with black so that it looks as if it were covered with a network. Sea bass are caught almost all along the northern Atlantic coast. The bait used is chiefly salted clams.

The **Striped Bass,** generally called rock fish south of New Jersey, is the largest of all the basses, some of them weighing sixty or seventy pounds, or as much as a boy ten years old. It is bluish-brown above and silvery-white below, and is marked lengthwise with brown stripes. It lives in the deep salt-water bays in the winter, and goes up rivers in the spring. Striped bass are caught generally with rod and line, with minnow, shiner, crab, shrimp, or shad-roe bait. They are sometimes caught also in nets.

Bass belong to the perch family of fishes, and the name bass is made from *barse*, which comes from the Anglo-Saxon word *bærs*, meaning a perch.

BASSOON, a bass wind musical instrument, used in ORCHESTRAS and military bands. It is made of a long tube of wood, usually maple wood or plane tree, and is in two parts, bound together side by side for sake of convenience. It is played by blowing through a bent brass mouth-piece, which is fitted with a reed or tongue like that in a clarinet. It has generally eight holes and ten keys, and the tube is bent together so that the fingers can easily reach them. Military bands have several sizes of bassoons.

The bassoon was first made by the Italians, who named it *fagotto* (bundle), because it is made of pieces

put together. The French call it *basson de hautboy*. *Basson* is from the Italian *bassone*, which comes from *basso*, bass, and the name is given to the bassoon because it is a bass instrument.

BAT, an animal with wings made of a thin membrane or skin, which is stretched from the fingers of the hands and along the sides back to the legs and the tail. The four fingers are very long and slender and joined together by the membrane, but the

Bat Hanging by its Toes.

thumb is short and armed with a claw. The feet have five short toes, all with hooked nails. Bats hang themselves up by these, with the head downward, as shown in the picture, when they sleep or are at rest, usually in some dark place. When they want to fly they let go and their wings at once spread out. They fly easily, and are very active in the air, but are awkward and clumsy on the ground. When a bat walks it reaches forward, catches hold of something with one thumb, and draws its body up to it; it then does the same with the other thumb, so that it makes a kind of zigzag movement.

In old times the bat used to be called a "flittermouse," and it was well named, for the common kind looks much like a mouse with wings. The color of both is nearly the same. The bat has small eyes, but the ears are large and its hearing is very sharp. The mouth too is large, so that it can easily catch insects when it is flying.

Bats are found in almost all parts of the world excepting the coldest, but chiefly in hot countries. Those in North America live mostly on insects, but the food of some foreign bats is principally fruits. The vampire bat of South America, when very hungry, will suck the blood of poultry and of animals.

The bat is a MAMMAL of the order *cheiroptera*, or hand-winged animals.

The word bat is changed from the old English *back*. The Scotch call the bat bakie-bird or bawkie-bird.

BATH. Bathing was a part of the religion of many ancient nations, particularly the Egyptians, Hebrews, and Greeks; and the laws of Mohammed require that the face, hands, and feet shall be washed five times a day. In the desert, where water is very scarce, Mohammedans do this with sand.

The public baths of the Romans in the times of the emperors were the most splendid that have ever been built. Those built by the Emperor Diocletian were large enough for eighteen thousand persons to bathe in at once, and those of the Emperor Caracalla were more than a quarter of a mile square. They had in them hot and cold water baths, hot air and vapor baths, swimming baths, waiting rooms, rooms for undressing, and courts for games and manly exercises, all adorned with

mosaics, marbles, paintings, and statues.

The **Turkish Bath** is a copy of the ancient Arabian hot air bath, which was largely used also by the Romans. The bather goes first into a room where the air is heated quite hot; when he begins to perspire he passes into a still hotter chamber, where the air is almost hot enough to cook an egg, and as soon as he perspires freely he goes into a wash room, where his body is scrubbed with soap and water, and cooled with a shower bath. He then plunges into a swimming bath in which the water is about as cool as the air, and after being dried passes to still another room, where he lies on a lounge, rolled up in a blanket, until his body is thoroughly dry and brought back to its common heat.

The **Russian Bath** is very much like the Turkish, excepting that hot steam is used instead of hot air. The Turkish bath can be borne at a much greater heat than the Russian. If taken with care these baths are healthful, but if either be taken too hot the blood will become so heated as to make it dangerous.

The **Cold Bath** always gives the bather a sudden chill when he plunges in, but this is followed by a feeling of warmth and a glow all over his body. This is called the reaction. If he leave the water at this time and rub himself dry, he will feel light and strong, but if he stay in long after the reaction, he will again become chilled and his body will feel weak. Thus, when properly taken, the cold bath is healthful, but if abused it is unhealthful. None but strong, healthy persons should bathe in cold water, and it should not be used when the body is tired or overheated by exercise.

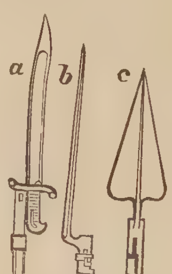
The **Warm Bath** is very pleasant, and gives no shock to the bather. It causes a gentle glow throughout the body, quiets the nerves, and causes the blood to flow quicker; but it does not strengthen like the cold bath, and if used too often it makes the bather feel changes of heat very quickly. Still, the best and pleasantest bath for a healthy person is one in which the water is tepid or lukewarm.

The **Hot Bath** brings the blood quickly to the surface, the skin becomes red and swollen, the pulse full, and there is a feeling of weight about the head. This causes fatigue and weakens the body. It should not be taken regularly by healthy persons, but if used the bather should begin with a lukewarm bath and then let in the hot water little by little. He should leave the bath before he feels any loss of strength, take a cold shower bath, and then rub himself dry with a coarse towel.

Sea Bathing in the proper season is healthful, as the salt is good for the skin and strengthens the body. But care should be taken not to remain in the water too long, as the reaction will pass off and the body become chilled. The body should be rubbed dry and the clothing put on at once on coming out of the water. No bath should be taken until two or three hours after eating.

The word bath is from the Anglo-Saxon *baeth*.

BAYONET, a steel pike or sword which can be fastened on the end of a gun, and used by foot soldiers. Before bayonets were made, men armed with long pikes or spears



Bayonets.

a, Sword Bayonet; *b*, Common Bayonet; *c*, Trowel Bayonet.

were mixed in with musketeers to help them to keep off cavalry, as horses cannot be forced to run on a sharp-pointed thing; but when bayonets were added to muskets, pikemen were no longer needed. Common bayonets are made straight and three-cornered, but some are like a sword, and others are shaped like a trowel, and can be used both to fight with and to dig the ground up to make banks of earth called intrenchments, behind which soldiers can lie in safety. These three kinds of bayonets are shown in the picture, *a* being the sword bayonet, *b* the common bayonet, and *c* the trowel bayonet. The improvement in rifles has rendered the bayonet of very little use in war, and it will probably be soon given up altogether as a weapon. The trowel bayonet, however, is still used to dig trenches and pits for riflemen.

The bayonet is named from Bayonne, in France, where bayonets are said to have been first made about 1640.

BEADS. The principle places for making glass beads are Murano, near Venice, and Birmingham, England; but many are brought from China also. They are made from glass tubes of different sizes, which are cut up into little pieces and then rounded on the edges by melting with a blow-pipe, or by mixing them with sand and wood ashes and then shaking them up in a red-hot iron pan until they are rounded. The sand and ashes keep the beads from melting together into one mass. The large beads used for doll's eyes are made in Birmingham. Beads are used for ornamenting slippers, purses, and fancy work, and great quantities are sent to Africa, India, and the islands of the Pacific, where they are worn as ornaments. In China every mandarin wears a string of beads when in full dress. The long beads called "bugles" are much used by ladies for trimming dresses.

Beads are made also out of metals, precious stones, coral, amber, wood, and many other things.

The word bead comes from the Anglo-Saxon *bead* or *bede*, a prayer; in former times beads were used to number prayers, as they still are used by some in strings called rosaries.

BEAN, the seed of several kinds of PLANTS which bear pods. The common bean is cultivated both in gardens and in fields. There are many kinds, with seeds of different shapes, sizes, and colors, some of which grow on running vines and some on bushy shrubs. Beans make good food for men and animals. Both the seeds and the green pods are cooked for the table. In Germany the pods are cut up while green and salted for winter use. The bean first grew in Western Asia and Northern Africa. The Egyptians cultivated it, and it was known in Europe in very early times. The Romans called it *faba*, and the family of the Fabii are said to have been named from it.

The French kidney bean, or haricot, and the Lima bean are the seeds of plants entirely different from the common bean. It is not known where the haricot first grew, but it was probably an American plant, as both it and the Lima bean (named from Lima in Peru) have been found in Peruvian tombs.

The word bean is Anglo-Saxon.

BEAR, a large animal found in Europe, Asia, and America, but not in Africa and Australia. Bears, though flesh eaters, eat also vegetables, honey, and other things. They live in both warm and cold climates, but those in warm countries are not so strong and savage as those in the polar regions.

There are many kinds of bears. The **Arctic** or **White Polar Bear** lives in the most northerly parts of Asia and America, and always near the sea, because its food is principally seals, fishes, and sea birds. It is very large, often weighing fifteen

hundred pounds, or more than a large horse, and is strong and fierce. In the winter it goes into its den, which is sometimes only a deep hole dug in the snow, and spends most of the time there until spring. It is a very cunning animal, and has many tricks for getting food.

A polar bear once saw a seal lying on the ice near a hole. He knew that if he went toward the seal on the ice it would go into the hole and escape him; so he crept along until he got as near as he could without being seen, then dropped into the water and swam under the ice until he reached the

Head of Polar Bear.

hole into which the poor seal expected to retreat, and coming up through it seized him.

The captain of a whaling vessel wanted the skin of a white bear whole and perfect, and thought he would try to kill one without shooting it; so he laid a cord with a running noose on the snow, and put a bait in it. A bear, going about on the ice, found the bait and got caught in the noose by one paw, but succeeded in getting it off with his other paw and carried away the bait. The snare was laid again. The bear came a second time, but remembering what had happened, he pushed the cord aside and again took the bait. The snare was laid a third time, the cord being hidden with snow, but this succeeded no better than the others. For a last trial the bait was put into a hole so deep that the bear could not get it without putting in his head, and a noose, hidden under snow, was put around it. But the bear had grown very suspicious by this time, and began by carefully pawing away the snow around the edges of the hole. He soon found the cord, put it aside, and carried off the bait as before.

But white polar bears are sometimes caught and are to be seen in most menageries. As they always suffer from the heat, blocks of ice are kept in their cages, pails of cold water are frequently thrown over them, and tanks are made for them to bathe in. In hot weather they may often be seen panting like a dog. The polar bear cannot be tamed, but always keeps up a stupid and brutal fierceness.

The **Grizzly Bear** of North America is found mostly in the Rocky Mountains and the great plains near them. It is the fiercest animal in North America, and often grows very large, being sometimes nine feet long, or half as long again as a man. Its hair is shaggy, and usually grizzled, or a mixture of black, white, and brown. When taken young, the grizzly bear may be tamed. James C. Adams, a famous California huntsman, had a female grizzly named Lady Washington, caught when about a year old, that followed him around like a dog. She slept at his feet by the camp-fire, carried burdens for him, followed him in all his hunting expeditions, and even fought for him with other grizzlies. Another one, named Ben Franklin, caught when a cub, was brought up by a greyhound in company with her own pup. He always showed the greatest affection for his foster-brother, the greyhound, and roamed and hunted through the woods with him. Once, when his master was attacked by a wounded grizzly, he joined in the fight with such ferocity as to save his master's life. Adams is said to have sometimes visited San Francisco with his pets, and to have walked through

the streets followed by a troop of unmuzzled grizzlies, which paid no attention to the yelping dogs and children that chased after them.

The **Black Bear** is found in all the wild parts of North America. Its fur is soft and smooth and glossy black. This bear is seldom more than five feet long, is timid, and lives mostly on vegetable food, although when oppressed by hunger it will carry off and eat hogs and calves. It is a great climber of trees, and often robs wild bees of their honey. The brown bear of Europe is much like it in character and habits.

The **Cinnamon Bear,** which lives west of the Rocky Mountains, is so called because its fur is the color of cinnamon. It also is much like the black bear in its habits.

Bears can be taught, by hard training, to do many tricks which, on account of the animal's solemn face, grave manners, and clumsy motions, are very amusing. They will dance to the music of fife and drum, stand on their hind legs and carry a stick as a soldier does his gun, and even jump through a ring with flame around it. Tame bears kept about a house often get troublesome and carry off things from the kitchen and pantry. One once tried to carry away a pot of hot coffee which the cook had set on the hearth, but spilled the coffee and burned himself. This made him so angry that he threw it down and smashed the coffee pot with one stroke of his paw. His master then fastened a log of wood with a chain to his collar, so that he could not get into the house. But Bruin did not like this and tried in vain to strike off the log with his paws. Then he dragged it down to the river and threw in the log, and got very angry because every time he tried to sink it it would come to the top again. At last he dug a hole, put the log in, scraped the earth over it, and stamped it down with his feet ; and, thinking he had got rid of his trouble, started to walk away, but found himself worse off than before. This made him still more angry, and he gave several hard jerks which broke the chain, and Bruin thus got free, leaving his tormentor buried in the ground.

The bear is a MAMMAL of the order *carnivora*, or flesh-eating animals.

The word bear is from the Anglo-Saxon *bera*.

BEAVER, a small animal valued for its fur. It is found mostly in the northern parts of North America and of Asia. It was once quite common

Fore Foot of Beaver.

in Europe, but it is now rare. The beaver is usually about two feet long, and weighs thirty to sixty pounds, or as much as a boy from three to six years old. Its color is reddish-brown or chestnut, but sometimes

Hind Foot of Beaver.

black ones are found, and sometimes ALBINOS, or white ones. Its fur is of two kinds, a soft, thick fur which grows next to the skin, and long, coarse, glossy hair on the outside. Each foot has five toes, but only the hind feet are webbed, so that in swimming they only are used, the fore feet being folded under the body. The tail of the beaver is

large and flat, and is used as a scull in swimming. Some writers say it is also used as a trowel to pound down the earth and clay with which it builds its house, but this is doubtful. Beavers always live near lakes or rivers, and where there are plenty of trees, because their food is mostly the roots of water plants and bark. They build their huts or lodges in groups near the edge of the water, scraping away the earth and mud in front so as to make the water deep; and they also dig holes in the banks near their huts, with their openings under water, into which they fly when their huts are attacked. When the water of a running stream is too shallow to make it free from freezing, they deepen it by building across it a dam of small trees, roots, branches, stones, moss, grass, and mud. Their teeth are so sharp that they can easily gnaw through a trunk five or six inches thick. All their work is done by night. They always lay up in summer a supply of food for the winter.

Beavers are hunted both in winter and in summer. In winter-time they are usually caught in their huts or holes, but in warm weather they are taken in nets and in traps baited with a substance called castor, which is got from a kind of pouch in the male beaver. Great numbers are killed yearly by the Indians and trappers in the far West for the sake of their furs. Beavers are easily tamed so as to answer to their name and to follow their master around like a dog. They love to be fondled, and will creep up into a person's lap and behave much like a petted cat.

Tail of Beaver.

In former times men's tall hats, which are now covered with silk plush, were covered with a felt made of beaver fur, and were therefore called beavers, a name still sometimes given to them. In England a law was once (1638) passed forbidding the use of any other material for hat-making, and the beaver was hunted so much that the supply was nearly used up; but since silk hats have been in fashion beavers have had some chance to increase in number. Beaver fur is now principally used for the trimmings of ladies' dresses and cloaks, and for men's collars and gloves.

The beaver is a MAMMAL of the order *rodentia*, or gnawing animals.

The word beaver comes from the Anglo-Saxon *beofer*, which is from the Latin *fiber*.

BED. Savages generally sleep on the ground on piles of leaves or boughs, or on the skins of animals. The East Indians sleep on the floor on light mattresses, which they roll up and put away in the morning; the Japanese lie on matting, resting their heads on a wooden rest which fits closely to the neck, and the Chinese on low bedsteads just raised above the ground. Most peoples in Europe have beds and bedsteads like those used in this country, but German bedsteads are shorter than others, and instead of sheets and blankets are covered with a second mattress made of down, almost as thick as the under one. The best beds are now made with steel springs, covered with mattresses.

Mattresses are filled with many materials, such as hair, wool, cotton, feathers, moss, cocoa-nut fibre, and shavings of paper or wood, but horse-hair mattresses are the best. Feather beds were once much used, but they are not so healthful as beds of hair. Pillows and bolsters are generally stuffed with hair or goose feathers. Beds should be turned over every day, so that the dampness caused by sleeping upon them may not make them musty.

The word bĕd comes from the Anglo-Saxon *bedd*.

BED-BUG. This insect is found in beds and pigeon houses, and in the nests of swallows and bats. It usually hides away in the daytime, and comes out at night to seek its food. It bites by pricking through the skin with a kind of three-jointed

Bed Bug.

Sucker of Bed Bug.

sucker, through which it also sucks blood. The bed-bug has a small head and a flat body; old ones are of a rust-red color, but the young are so light that one can almost see through them. It is hatched from oval white eggs, and is full grown in eleven weeks. Bed-bugs are very hard to kill; one has been kept alive in a sealed bottle without food for more than a year. Cockroaches are the enemies of bed-bugs, and kill great numbers of them.

The bed bug is an INSECT of the order *hemiptera*, or half-winged insects.

BEE. There were no honey bees in America until they were brought here by Europeans, but they are now found all over North and South America, although they did not reach South America until 1845 and California until 1850. The Indians call them the white man's fly, because they go wherever the white man settles.

Bees live in communities or societies, and are divided into females,

Honey Bee—Queen.

males, and workers. Each hive has but one female, called the queen, who governs the society and lays the eggs. The males, who do no work, are called drones, and there are sometimes several hundreds or even thousands of them in a hive, there being usually one in every thirty bees. The queen bee seldom leaves the hive except in the swarming season, after which all the drones in the hive are killed by the workers. The workers, who form the principal part of each society, do all the work, gathering the honey, making the wax and building the cells, and feeding and taking care of the young.

Bees are very strong, and can fly very fast and for a long time with-

Honey Bee—Drone.

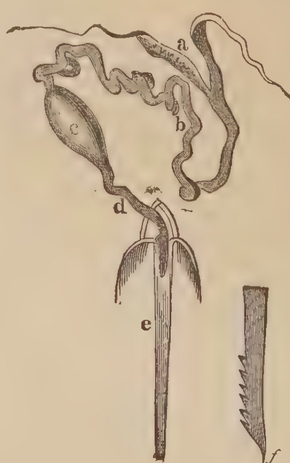
out lighting. Their eyes are made to see at great distances; when absent from home they go up into the air until they see the place where their hive is, and then fly toward it in a straight line with great speed, from which the shortest line between

two places is sometimes called a "bee-line." This habit of bees is well known to hunters of wild honey, who often find hives in the woods by following bees that are going home. Drones have no stings, but the females and the workers each

Honey Bee—Worker.

have one at the back part of the body. The sting of a bee is shown in the picture. In this *a* is the place where the poison is made, *b* the tube through which it is carried to *c*, the poison bag, where it is kept for use, and *d* the tube through which it flows to the sting. The sting is made of a sheath, *e*, in which are two darts, with sharp points and ragged edges like saw-teeth, one of which, much enlarged, is shown in *f*. When a bee stings it first makes a wound with the sheath, along which the poison flows in a groove; and it then thrusts in the darts to deepen the wound. The saw-teeth edges are very hard to pull out, and bees are often so hurt in trying to get them out quickly that they die. Bee poison is so deadly that a single sting will kill an insect, and animals and men have been sometimes killed by bees which attacked them in great numbers.

When the queen bee has paired with one of the drones she goes to work to lay eggs, laying sometimes as many as two or three thousand in a day. Worker eggs are first laid in one set of cells, and then drone eggs in another; and if the hive is very full and it is thought best to have another queen, she lays a third set of eggs in a third set of cells. In three days the larvæ, which look like small, white worms, come out of the eggs. They are fed by the workers with the pollen or dust of flowers mixed with honey and water. After five or six days more the larvæ begin to spin a covering or cocoon around themselves, from which the workers come out, perfect bees, in twenty days, and the drones in twenty-four days. Queen bees are ready to come out of the cocoon in sixteen days. If the hive is not full the new queens are all stung to death in the cells by the old queen; but if the colony is large, one of the new queens is permitted to come out. As soon as she appears, the old queen leaves the hive, taking with her a part of the bees, and goes off to form a new one. This is called swarming, because when they leave the hive they usually collect in a mass, called a swarm, on the branch of a tree, a bush, or some other



Sting of Honey Bee, much Enlarged.

e, Stings in Sheath; *f*, Point of one of the Stings.

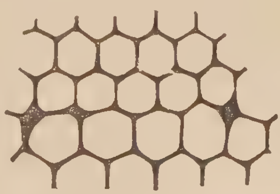
handy place, as shown in the picture. If the owner of the bees then sets an empty hive near them, they will go into it and set to work to make wax and honey, just as they did in the old one. The new queen of the old hive rules until another queen

appears, when she too leaves and founds a colony. When two queens come out at the same time, they fight until one of them is killed.

The food of bees is of two kinds, the pollen of flowers and sweet juices. The pollen is gathered on the hairs of their legs and carried to the hive for the food of the young ones. The juices of flowers are licked up by the hairy proboscis, or trunk, which serves as a sort of tongue. This, which is made up of several parts, can be lengthened, shortened, twisted, and bent in any way, so that it gathers all the sweets from the petals and the bottom of the flower-cups. If a flower is not full blown, the bee will open it wide enough to get in its proboscis for the juices and its front legs for the pollen. Bees also gather a great deal of honey from the sweet juices which plant lice scatter in little drops upon the leaves of trees. Juices are carried by the proboscis into the mouth, from which they pass into the honey bag, a kind of first stomach, where they are changed into honey; but they are not digested, for bees have a second stomach for the digestion of food. The honey can be brought up from the first stomach at will, either to feed the young or to be stored up in the cells.

Swarm of Bees.

WAX is made only by the working bees. They have a pouch in the back part of the body in which the wax grows little by little. When the pouch is full the wax sticks out in little scales, and either the bee himself or some of his fellow-workers take it off and use it in making honey-comb. The cells in the comb are always made six-sided, as shown in the picture, so that no room is wasted. They are at first soft and white, but soon become firm and dark yellow. Cells made for HONEY and pollen are about twice as large as those for hatching, and are always built with their mouths slanted upward, so as to be easier filled. The honey-combs, which are begun at the top of the hive and built downward, are about an inch thick, and are each made up of two sets of cells placed back to back. Between every two combs is left a space about half an inch wide, so that the bees can carry honey to the cells. As each one is filled, it is sealed up with wax. The honey and pollen thus stored up serve the bees for food during the winter. Farmers often take the honey with care out of the



Cells of Honey Comb.

combs and put the empty combs back into the hive to be again filled by the bees.

The honey bee is an insect of the order *hymenoptera*, or membrane-winged INSECTS.

The word bee comes from the Anglo-Saxon *beo*.

BEECH. The beech tree grows in Europe and America. In the United States it is sometimes more than a hundred feet high, or four or five times the height of an apple tree, and makes a beautiful shade tree. It is so seldom struck by lightning that the Indians consider themselves safe under its shelter in a thunder storm. It bears little three-cornered nuts, which squirrels and other small wild animals and some birds like very much. They are fed also to swine and poultry, and some people like them, but they are apt to cause giddiness if too many are eaten. In France beech oil is made out of them, which is both eaten as salad oil and burned in lamps. Beech wood rots easily in the air, but not under water, and is used for making mill-wheels. It is made also into shoe lasts, tool handles, bowls, rollers, etc., and in France into *sabots* or wooden shoes.

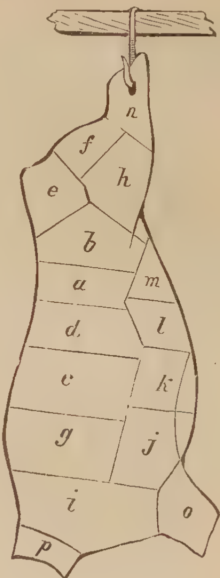
The copper beech, with copper-colored shining leaves, and the purple beech, with blood-red leaves, are ornamental trees, often seen in parks.

The word beech comes from the Anglo-Saxon *bece* or *bœce*.

BEEF, the flesh of the ox or cow, when killed. Beef is the best kind of meat for food, and is richer in flavor and more easily digested than any other meat. Good ox beef is bright red with yellowish fat, and has a loose grain; cow beef is not quite so red, the fat is whitish, and the flesh a little firmer. Poor beef, or beef too old for food, is usually dark red, with hard, skinny fat.

An animal for beef is cut up by the butcher into parts, as shown in the picture. These parts are cut into smaller pieces by the retail butcher, when he sells the beef to families.

Corned beef is made by soaking the lean parts in a pickle made of salt, saltpetre, and a little brown



Animal cut up for Beef.

a, Porterhouse Steak; *b*, Sirloin; *c*, Middle Ribs; *d*, Fore Ribs; *e*, Rump; *f*, Mouse Buttock; *g*, Chuck Ribs; *h*, Round; *i*, Clod; *j*, Shoulder; *k*, Brisket; *l*, Thin Flank; *m*, Thick Flank; *n*, Leg; *o*, Shin; *p*, Neck.

sugar. Smoked beef is first cured in pickle, like corned beef, and then smoked over a wood fire. Beef cut into thin slices or strips and dried in the sun is called jerked beef.

The word beef comes from the French *bœuf*, which is from the Latin *bos*, genitive *bovis*, Greek *bous*, an ox.

BEER, a drink made out of malt, hops, and water. Malt is made chiefly of barley, though wheat, rye, oats, Indian corn, and in India rice are sometimes used. The person who makes the malt is called a malt-

ster. He wets his barley in great heaps and then spreads it over the floor of a dark room, where it swells and sprouts just as it would if it were planted in the earth. It is then dried on the floor of a kiln, when the little sprouts drop off and are afterward sifted out. The sprouting is stopped just at this time because the grain then has in it the most sugar; if the sprout was allowed to grow more it would use up the sugar. The barley, which is called malt at this stage, is dried a long or a short time according to the kind of beer that is wanted. For light-colored ale, which is the name of several kinds of beer, it is dried a short time; for dark-colored or heavy ale, a longer time; and for porter and brown stout, stronger kinds of beer, the malt is dried until it is browned. Brown stout gets its name from its color and strength. Porter, which was first made in England in 1730, is still darker. It is so called because it was a favorite drink with porters and other laboring men.

Malted barley has a much sweeter taste than fresh grain, for it has more sugar in it. It is also softer, and can easily be crushed in the fingers. The malt is now ground or bruised, when it is called grist. The grist is put into a large wooden tub and mixed up with hot water. Another change now takes place in the barley—most of the starch in it is turned into a kind of sugar called grape SUGAR. The water melts this sugar, and gets from it a pleasant sweet taste. The liquid, which is now called sweet wort, is next drawn off and boiled in a great copper kettle with HOPS. Hops give the bitter taste to beer, so that more or less is put in according to the bitterness wanted in it.

After boiling, the liquor is strained and cooled as quickly as possible, and put into a large vessel called a fermenting tun. A little YEAST is added, and after it has stood a while it begins to bubble up and to froth at the top, and in a short time a change takes place in it. After this change, which is called fermentation, the liquid has a new taste and smell; the sweet taste of the sugar is gone, and it is much stronger and sharper than before. This is because the sugar in it has been changed by the action of the yeast into two things, CARBONIC ACID and ALCOHOL. Alcohol is made up of just the same things (CARBON, OXYGEN, and HYDROGEN) as sugar, only they are put together in different proportions. When yeast causes the sugar to turn into alcohol, it simply takes from it some of its oxygen and some of its carbon, and forces them to unite, forming carbonic acid, which passes off in bubbles of gas into the air. All of the hydrogen of the sugar remains behind, and uniting with what is left of the oxygen and the carbon, becomes alcohol. Any liquor which has passed through the change of fermentation is called a fermented liquor.

The beer is now put into large hogsheads and left to settle until it is clear, when it is pumped into beer barrels for sale. The German beer called *lager bier* is fermented in a different way from ale, the yeast being put into the bier in the casks, which are then laid up in cool cellars, where the fermentation goes on slowly. What we call lager bier in this country is properly *schenk bier*, for it is not kept long enough in cellars to be called *lager*, which in German means something laid up. The name of beer is also sometimes given to drinks made from spruce, sassafras, ginger, and other herbs and roots, but they are generally called root beer. The way to make beer from malt was first found out by the ancient Egyptians, who made theirs from barley. In the time of Tacitus (P. &. P.) it was in common use among the Germans, and also among the Britons and Celts.

The word beer comes from the Anglo-Saxon *beor*, which is from

bere, barley. Ale is from the Anglo-Saxon *eala*.

BEET. Many kinds of beets are cultivated, but the principal ones are the common beet, the mangel-wurzel, the chard, and the sea beet. There are several varieties of the common beet, all different in shape, size, and color. The small red and the long yellow are the best for table use. Mangel-wurzel beets are larger and coarser than common beets, but very sweet, and make excellent food for cattle in winter. The chard is a small beet much eaten by farmers and laborers in Germany and France. The sea beet is cultivated in gardens for use as greens. The leaves of the beet, especially of the white beet, are often boiled and eaten as greens.

Beet sugar is made from the juice of the common white beet. It was first made in France in the time of the Emperor Napoleon I., who, being at war with England, would not let British cane sugar be brought into the country. When refined, it looks and tastes like the best cane sugar. Molasses also is made from it, which is distilled (see ALCOHOL) into a spirit.

The Hebrews did not know the beet, but the Greeks and Romans cultivated red and white beets and ate both the roots and the leaves. All the kinds known to-day are supposed to have come from the sea beet, so called because it grew on the sea coast.

The word beet comes from the German *beete*, which is from the Latin *beta*.

BEETLE. Beetles may be known from other insects by the two horny sheaths or wing-covers called *elytra*, which cover their true wings so closely, when they are not flying, that they look as if they had no wings. The wing-covers are often very beautiful, being of various colors, blue, green, yellow, etc., and sometimes spotted with gold. The wings, which fold up under the covers very curiously when closed, are commonly twice as long and twice as wide as the covers. Most beetles' legs are long and fitted for running, and they have two strong horny mandibles or jaws, made for gnawing and chewing. They live on different kinds of food, some on other insects and worms, some on carrion, some on rotten wood and some on growing wood, some on grain, some on roots, and some on leaves and flowers.

Beetles pass through three full stages or changes in life. The larvæ or grubs have long, flat, worm-like bodies, with horny heads and three pairs of legs; but some, which are hatched inside of nuts and fruits, have no legs. Before going into the second or pupa state, the larva often makes a case or cocoon for itself out of earth, or of little chips and dust fastened together by threads. Larvæ sometimes lie in these cases for years before turning into full beetles.

Tiger Beetles.

Beetles are found mostly in woods under leaves, logs, and stones, under the bark of rotting trees, or in ditches and beside streams. Some live in the water, and may often be seen darting over the surface catching little insects. There are many thousand kinds of them, more than eight thousand of which live in the United States. **Tiger Beetles** are so called from their stripes, and because they are as fierce among insects

as tigers are among quadrupeds. They prey on caterpillars, flies, and other beetles, and will even eat each other when shut up together. The pictures of two kinds of common tiger beetles are given on p. 80.

Bombardier Beetle.

The **Bombardier Beetle** is so called from its habit of shooting a strong liquid from behind at its enemies; bombard being an old name for a cannon. **Scavenger Beetles** have feet fitted for digging, and make deep holes in the ground. They live on filth, of which they clear up a great deal. Some of them are called **Carrion Beetles** because they eat up dead animals. Others, called **Sexton Beetles,** bury the bodies of animals. They have a very strong scent, and when they smell the dead body of a mouse, frog, or other small animal, they gather round it and examine the ground. If it is hard and stony, they look for a better place, and then a great many of them together carry the body there; but if the ground is soft they all set to work digging with their long legs under it till the animal sinks down into the hole. They then lay their eggs in it, cover it up, and when the larvæ are hatched they feed on it. If they left the body above ground, it would dry up and become unfit for their food, or some other animal might eat it. Among this class of beetles are also those commonly called tumble-bugs, which make little balls out of manure and then roll them away with their hind legs. They lay their eggs in these balls, and roll them into deep holes which they dig. If the road is too rough they lift them upon their heads, which are broad and flat, and thus carry them. The ancient Egyptians thought these animals were so useful in manuring the ground with their balls that they called them sacred beetles, and worshipped them. They also carved figures of them in gold, precious stones, and other materials, and wore them as ornaments and charms. Many of these are still found in ancient tombs, and are called *scarabæi* (beetles, plural of Latin *scarabæus*, a beetle).

The **Carpet Beetle,** common in Europe, but not known in the United States before 1872, is more destructive to carpets than the carpet moth. It eats also woollen clothing, furs, leather, collections of animals, birds, and insects, dried meats, and many other things. It is most destructive in the larva state, when it is only about three-eighths of an inch long, with long brown bristly hairs along its sides pointing backward. When it becomes a beetle, it is only about one-eighth of an inch long. If captured, it folds up its legs and pretends to be dead. Carpet beetles are most plentiful in May, but they continue their ravages all summer long.

Other wonderful beetles are the stag-horn beetles, whose long jaws look like the horns of a stag. Our common **Horn Bug** belongs to this class. In some countries this kind of beetle is very useful in clearing up dead wood in forests. They lay their eggs in the bark of trees blown down by tempests, and their grubs eat up the whole tree, which is thus turned to dust and enriches the earth. The **Spring Beetle** or snapping bug is so called because when laid on its back it can spring up, turn over, and come down on its feet. The **June Bug** is a kind of beetle that is common in the Northern United States in June. In the South, where it appears earlier, it is called the **May Bug. Curculios** or weevils are a kind of beetles that live on fruits and grains, and do great injury to crops. The worms found in plums, apples, chestnuts, and other fruits come from eggs laid in them from beetles. The **Spanish Fly,** which is ground to powder and

made into blistering plasters, is a bright green beetle. FIRE FLIES or lightning bugs, LADY BIRDS, potato bugs, squash bugs, and many other common insects also are beetles.

The beetle belongs to the order *coleoptera*, or sheath-winged INSECTS.

The word beetle is from the Anglo-Saxon *bîtel*, which is from *bîtan*, to bite.

BELL. Bells have been made of different kinds of metal, but an ALLOY of copper and tin, called bell-metal, is thought to be the best. This is usually made of three parts of copper to one part of tin, and a little zinc and lead are sometimes added. Very good bells are now made of cast-steel in England and Germany. Bells of fine tone have been made out of glass, but they break too easily to stand long the blows of the tongue. In casting bells the first thing to do is to make the mould, which is built up of fine sand. (See STATUE.) The core or part which fills the inside of the bell is first made, and then around this is built up the outside, which must be as far from the core as the bell to be cast is thick. A place is left at the top to pour in the metal, which is drawn off from the furnace into a great crucible or earthen pot. This is swung by a CRANE, to which it is fastened by chains, over the mould, which is in the pit beneath the floor, and tipped up and the metal turned in as fast as it will run. After cooling, the mould is drawn out of the pit, and the bell, which is very rough, is finished with chisels and files.

The largest bell in the world is the one called Tzar Kolokol (King of Bells), in Moscow, Russia. It was cast in 1733, but fell during a fire and remained buried in the earth until 1836, when it was raised by the Emperor Nicholas. It is more than three times as high as a man (19 feet and 3 inches), and weighs as much as two hundred and twenty common cart-loads of coal (443,000 pounds). It has a large piece broken out of its side, so that it cannot be rung, and it is set upon a stone foundation and used as a little church, of which the broken place is the door. Another great bell in Moscow, the largest in the world in use, is more than thirteen feet across at the bottom, or about as wide as a fair-sized room, and weighs as much as eighty cart-loads of coal (160,000 pounds). The next largest bells in the world are in Peking, China, where there are eight each weighing as much as sixty loads of coal (120,000 pounds). The largest bell in America is in the Cathedral of Notre Dame in Montreal: it weighs nearly as much as fifteen loads of coal (29,400 pounds). The largest bells in New York are those once used on the fire alarm towers; they weigh as much as five loads of coal each (about 11,000 pounds). One of the most noted bells in this country is the Liberty Bell in Independence Hall, Philadelphia, which was rung when independence was declared. It is badly cracked, so as to be unfit for use. Some churches now have chimes or peals of bells. The best chimes consist of eight to twelve bells of different sizes, so made that they sound musical notes, like those of a piano. Tunes can thus be played on them.

The ancients used bells very much as they are used to-day; they were rung in the houses, by tradesmen in the streets and markets, and as signals in camps; they hung them on the necks of cattle and goats, just as people in the Alps now do, and decorated horses with them. Church bells were first used about A. D. 400 by Bishop Paulinus of Nola in Italy, and they came into use in England and France about the seventh century. The curfew bell (French *couvre-feu*, cover fire) was rung in England at eight o'clock as a signal to warn people to put out fires and

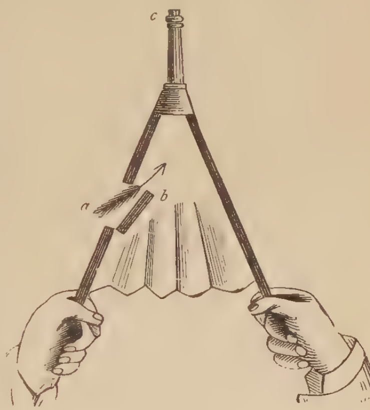
lights, necessary then when so many buildings were of wood and thatched with straw. The custom of ringing the curfew was kept up until the sixteenth century.

In old times it was believed that bells had the power of driving away evil spirits: and so it was the custom to ring the church bell when a sick person lay dying, to frighten away the evil spirits which were supposed to stand about the foot of the bed waiting for his soul. A bell rung at such a time was called a "passing bell," because the dying person was passing away to another world. The passing bell was also rung when a funeral was passing, that those who heard it might pray for the soul of the departed. It may still be heard in some New England villages, where the church bell is often tolled as many strokes as the years of the dead person's life. Bells are often pealed too for marriages, and rung on public occasions, such as fires, invasions, etc. Bells were once thought to have the power of protecting buildings from lightning and tempests, and some church bells had the following verse engraved on them:

"Men's death I tell by doleful knell,
Lightning and thunder I break asunder,
On Sabbath all to church I call,
The sleepy head I raise from bed,
The winds so fierce I do disperse,
Men's cruel rage I do assuage."

The word bell is from the Anglo-Saxon *bellan*, to make a loud sound. Our word bellow also comes from it.

BELLOWS, an instrument or machine used for making a blast of air for blowing fires, for giving air to mines, for filling organ pipes with wind, etc. Common bellows are made of two wooden sides, whose edges are joined together by a strip of leather, fastened all around to both, so that the sides will rise up from and close down upon each other. Through one of the sides is a hole, *a*, covered on the inside with a VALVE, *b*, made so that it will open and shut like a little door, and at the end is a nozzle or small tube, *c*. When the two sides are raised up from each other, as shown in the picture, the outside air pushes open the valve and fills the inside of the bellows. On pushing the sides together again the air inside closes the



Bellows.

valve, so that it can get out only through the nozzle, and as this is much smaller than the valve it rushes out with much more force than it entered and makes a strong blast. Another kind of bellows is told about under ORGAN.

The word bellows comes from the Anglo-Saxon *baelg*, a bag, the first bellows having been made like a bag.

BERGAMOT, a kind of citron, belonging to the same family of fruits as the orange, lemon, and lime. It is sometimes called also bergamot orange, as it is round and looks much like an orange. From its rind is distilled (see ALCOHOL) the oil of bergamot, much used in making perfumery, eau de cologne, hair oils, essences, and liqueurs. Oil of bergamot is made also by grating

the rind and then pressing it in glass vessels.

The word bergamot is from the French *bergamotte*, named from the town of Bergamo, Italy, from which the fruit is said to have first come.

BERYL, a precious stone, of the same mineral species as the emerald and the aquamarine. It is made up chiefly of silica and alumina, like the emerald, but differs from it in color, being often blue, pale green, yellow-green, golden-yellow, and even white, Beryls are found in upper Egypt, Siberia, Hindustan, Ceylon, and South America. Many have been found in the United States, especially in North Carolina, Colorado, Arizona, and in New England. Some very beautiful yellow, pale green, and white ones have been got near New Milford, Conn. A beryl weighing 80 pounds is in the museum at Stockholm, Sweden, but the largest ones in the world are found at Ackworth and Grafton, N. H. One from Ackworth in the Natural History Museum, Washington, weighs 600 pounds, and one from Grafton, three and a half feet long by three feet wide, weighs several tons. These are both pale green, and are coarse and of little value.

The word beryl is from the Latin *beryllus*, Greek *berullos*.

BIRCH, a tree growing in Europe, Asia, and America, generally in cold places. There are several kinds, the **White Birch,** which has white bark, being the most common. It grows higher on the Alps than any other tree, and is almost the only tree found in Greenland, where its bark is used for covering houses. It is a very useful tree; in some countries its bark is made into shoes, hats, shingles, boats, drinking-cups, and ropes, and its wood is used by turners, coopers, and wheel-wrights.

The **Paper Birch,** which grows in Canada and the Northern United States, has a very tough bark, out of which the Indians make their canoes. They also make beautiful boxes, baskets, buckets, and cups out of it, and thin sheets of it are used for paper.

The **Black Birch,** called also the mountain and the sugar birch, grows throughout New England and westward to Ohio. Its wood is rose-colored, hard, and fine grained, and good for cabinet work. Its leaves and bark have a sweet smell and pleasant taste. In Connecticut birch oil is made from its twigs, by boiling them in tanks and distilling (see ALCOHOL), and sold as oil of wintergreen for use in making confectionery.

The **Red Birch** grows in the Southern and Middle States. Birch brooms are made from its twigs and its branches make excellent barrel hoops. Russia leather is tanned with birch bark, which gives it its delightful smell.

The word birch is from the Anglo-Saxon *birce* or *beorc*.

BIRDS. Birds, like MAMMALS, are warm-blooded, but they differ greatly from mammals in many other things. They are all oviparous (Latin *oviparus*, from *ovum*, egg, and *parere*, to bring forth), that is, their young are hatched from eggs which are laid by the parents, and they do not suckle their young. With few exceptions they are covered with a coat of feathers, which are mostly fitted for flying, while among mammals only BATS can truly fly. They have hard horny bills, in place of teeth; and they have a gizzard to grind their food, which is found in no other animals.

As birds are much heavier than the air, they have to use a great deal of strength to fly in it. The bones in their wings are much like those in the arms and hands of man, but the MUSCLES which move them are much stronger for their size than those in man. All birds that use their wings much have a sharp strong ridge standing out from the front of the breast-bone, something like the cut-water or keel on the

bow of a vessel. On each side of this are fastened the muscles, which enable them to spread out and work their wings so as to raise their bodies into the air and keep them there a long time without resting.

Some birds which do not fly, like the ostrich, whose wings are of little use save only to aid it in running, have no need of such strong muscles, and the breast-bone has therefore no ridge at all, but is nearly flat, like that in man.

To enable birds to fly, swim, or move rapidly on land, it is necessary that they should be not only very strong, but also very light. Their bones are therefore made thin, and their whole body is filled with numerous air cells. Birds which fly highest and fastest have the most air cells; the eagle, for instance, has them in all its bones, but the ostrich only in its thigh-bones. The air from the lungs, which is much warmer and therefore lighter than the outside air, passes into and out of these cells at the will of the bird, some birds being able to fill even the quills of their feathers. All this adds much to the lightness of the body, but still the bird could not fly if his wings were not fitted with long FEATHERS, which add to the size of the wings without making them much heavier. The feathers on the under side of the wing, which strike against the air in flying, are larger and stronger than the others, and are called quill-feathers or simply quills. At the base of the quills, on both sides of the wing, are smaller feathers called wing covers. The tail feathers, which are like the quills of the wings and have covers above and below them, serve as a rudder to guide the bird in flying and to balance it in the air. They are also the principal ornament of most birds. The bodies of birds are covered with a thick coat of down and feathers, their swift motion in flying being apt to cool the blood, just as fast motion in a carriage or boat has the effect of a cooling breeze; so they need warmer clothing than most animals. Arctic birds are more warmly clad than those which live in hot climates, but the latter have more beautiful plumage. Birds moult or change their feathers usually once a year, and their colors vary much between summer and winter.

Birds live on different kinds of food: some on flesh alone, some on fish, some on insects, some on seeds of plants, and some on a mixture of all these kinds. Most of them swallow their food whole or simply torn into pieces. It goes, when swallowed, through the gullet into a first stomach called the crop, where it is soaked and softened. It then passes through another part of the gullet, where it becomes mixed with a liquid called gastric juice, into another stomach called the gizzard, which is made up of strong muscles, and has a very tough leathery lining. This acts like a kind of mill, the muscles rubbing the two sides of the lining together and grinding the food as between mill-stones. To add to the grinding power of the gizzard, birds swallow sand and small stones, which aid in crushing hard food. The gastric juice, which is a kind of acid, helps to digest the food. The gizzard is most perfect in birds which live on seeds and grains; in other birds it differs according to their food. Those that live on fish have no gizzard, as their food is easy to digest without grinding.

The inside parts of the common fowl are shown in the picture, in which *a* is the gullet, *k* the crop, *b* the part of the gullet where the gastric juice is made, *c* the gizzard, *i* the liver, *d*, *e*, *f*, and *h* parts of the intestine, and *g* the place where the waste parts of the food pass off.

Birds have most of the senses, but those of taste and of touch are generally very dull. But their sight is very keen, especially in birds of prey. Their eyes are wonderfully

made and are fitted with a kind of thin skin or membrane inside of the eyelids, which they can draw down at will, and which, while they can see through it, protects the eyes from injury and enables them to look at the sun without being dazzled by its rays. The nostrils of all birds

Inside Parts of Common Fowl.

open on the top of the beak, and it is supposed that some birds, such as birds of prey, have a strong sense of smell; but this is denied by some writers. With a few exceptions, birds have no outer ear, but they all have the sense of hearing. All birds have some kind of a cry, but many have no song. Both sexes call to each other, but of the singing birds only the males, as a general rule, are able to sing. Water birds are more noisy than land birds, and tame birds sing more than wild ones. Generally, birds of bright and beautiful plumage do not sing so sweetly as those which are less gayly dressed. Many birds change their homes with the change of the season. Most of those which enliven our fields and forests during the summer leave with the coming of cool weather for the south, where they can more easily get food during the winter; but they always return with the spring, and many visit the same places year after year.

All birds lay EGGS, mostly in carefully built nests, but a few lay them on the bare ground or in the sand of the seashore (see BIRDS' NESTS). They hatch their young from the eggs by sitting on them, but a few leave them to be hatched by the sun. The object of sitting on them is only to keep up the right amount of heat, the warmth of the body being just enough for this. Equal warmth made in any other way will do as well. Eggs may be hatched by steam or oven heat. When the time comes for a bird to be hatched, it cuts its way out of the shell by means of a hard scale fitted to the end of its beak, and which soon after falls off. Some birds are able to run about and to pick up food as soon as they leave the shell; others are hatched without feathers, and need to be fed and cared for by their parents for days and even weeks.

The legs of birds are made much like those of man. The feet are divided into toes, usually three in front and one behind; but some, as common fowls, have a fifth toe or spur behind; some, as the bustard, have no hind toe; some, as the parrot, woodpecker, etc., have two toes in front and two behind; while the ostrich has only two toes forward and only a part of one behind.

Birds' feet vary according to their mode of life: some have strong, hooked claws; some long, straight, weak ones; some have the toes all

Foot of Bird of Prey—Falcon.

separate, and some have them connected with a web or membrane.

Birds are divided into seven orders according to the shape of their feet and claws:

I. **Raptores,** or birds of prey, which have short stout legs and four toes, three in front and one behind. all armed with strong curved claws or talons made for seizing and holding their prey. The upper bill in these birds is longer than the lower, and forms a kind of hook, which shuts over the under one. There are three families of *raptores:* 1. Vultures. 2. Falcons (including eagles and hawks). 3. Owls.

The word *raptores* is from the Latin *rapere*, to seize.

Foot of Perching Bird—Lark.

II. **Insessores,** or perching birds, which have short slender legs and four long thin toes, three in front and one behind, with long, slightly curved claws, fitting them for perching on trees. They include all the birds living in trees, excepting birds of prey and the climbers. They are divided into four families: 1. Cone-billed birds, or those with a beak shaped like a cone, including the crows (crow, rook, black-bird, jay, etc.), the finches (larks, sparrows, linnets, etc.), starlings, (meadow lark, oriole, etc.), and birds of paradise. 2. Tooth-billed birds, having a tooth or notch near the end of the beak, including the thrushes (robin, mocking bird, catbird, etc.), warblers (blue bird, chickadee, etc.), and fly-catchers (king bird, phebe bird, etc.). 3. Split-beaked birds, whose bills are divided far back, so that they can open the mouth very wide, and thus catch insects while flying. Among these are the swallows, the goat suckers, kingfishers, bee-eaters, and others. 4. Slender-billed birds, whose long slim bills fit them for sipping the honey from flowers, or

Foot of Perching Bird—Kingfisher.

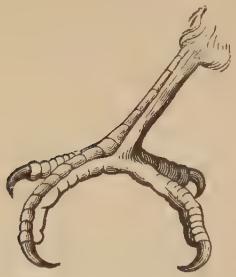
for reaching into narrow places to catch small insects. Among these are the humming birds, which are found only in America.

The word *insessores* is from the Latin *insidere*, to sit upon.

III. **Scansores,** or climbing birds, which are fitted for climbing, having two toes in front and two behind. Some of these have three toes in front, but they have the power of turning back the outside one when they wish to climb. There are four families in this order: 1. Parrots. 2. Toucans. 3. Woodpeckers. 4. Cuckoos.

The word *scansores* is from the Latin *scandere*, to climb.

IV. **Rasores,** or scratching birds, whose feet and claws are fitted for scratching in the earth. Their chief



Foot of Climbing Bird—Woodpecker.

families are: 1. Pigeons (including doves). 2. Curassows. 3. Pheasants (peacocks, common fowls, turkeys, and pheasants proper). 4. Grouse (partridges, prairie hens, quails, etc.).

Foot of Scratching Bird—Pheasant.

The word *rasores* is from the Latin *radere*, to scratch.

V. **Cursores,** or running birds, marked by the length and strength

Foot of Running Bird—Cassowary.

of their legs, and by their small and weak wings. As they do not fly, the strips which make up the soft parts of their FEATHERS are not hooked together by exceedingly small barbs as in other birds. So their feathers curl. Among them are the ostrich, the emu, and the cassowary.

The word *cursores* is from the Latin *currere,* to run.

Foot of Wading Bird—Crane.

VI. **Grallatores,** or wading birds, which have long legs like stilts, enabling them to wade, and long necks

Foot of Swimming Bird—Pelican.

and bills so that they can reach their food in the water. They live mostly on MOLLUSKS and water worms and insects. Their chief families are the cranes, the herons, the plovers, the snipes (including woodcock), and the rails.

The word *grallatores* is from the New Latin *grallæ*, stilts.

VII. **Natatores,** or swimming birds, which are web-footed—that is, their toes are connected with a kind of skin or web so that their feet serve as paddles in swimming. Their legs are usually short and are set back further than in other birds, and their necks are long. Their families are the ducks (including ducks proper, geese, and swans), divers, auks (including penguins), gulls (including the petrel and the albatross), and pelicans (including the cormorant).

The word *natatores* is from the Latin *natare*, to swim.

Birds make up the second class of vertebrate ANIMALS.

The word bird comes from the Anglo-Saxon *bird* or *brid*.

BIRDS' NESTS. Birds differ from all other kinds of animals in building nests to lay their eggs and to hatch their young in. Different birds have different kinds of nests, some of which are very simple and rude, and some wonderful in their plan and in the way in which they are built.

Birds may be divided, according to their nests, into two great classes, those which build on or in the ground, and those which build above the ground, in trees, etc. Among ground building birds are included all which dive under water, almost all which swim, and a large part of those which live along the shore and wade in the water. Some that are classed with the ground builders make no nest at all. Thus many water birds lay their eggs on the bare surface of rocky cliffs or in sandy places along the shore. Among land birds the whip-poor-will makes no nest, but lays its eggs on dry leaves in the woods, and the night-hawk drops its eggs on bare rocks or sometimes on the flat roofs of houses. Other ground builders make hollows in the sand for their eggs, and some build nests of reeds, sticks, and leaves near the edge of rocks near the water. Among these last are most of the sea ducks, geese, swans, and gulls. The eider-duck builds first a rough platform of sea-weeds and rushes, and then covers it with DOWN taken from its own breast.

It is said that water-fowl always build their nests on the sides of rocks which look toward the west and northwest. The archipelago of Faroe, between the island of Faroe and the Shetland Islands, is a favorrite place for sea birds. There are twenty-five great rocks there called Vogelberg (Bird-rock), on which birds of many kinds build their nests every year. One of these is an immense black rock, more than a quarter of a mile high, formed of many layers and ledges which reach to its top. Boats can go near it only in calm weather, when the sea at its foot is smooth. When the weather is stormy the sea roars and boils around it, and dashes its waves up its steep sides nearly as high as a steeple, falling back in foaming showers. This is the home of millions of birds, who build their nests side by side on its ledges, where they may be seen sitting day after day, during the hatching season, with their heads all turned toward the sea. The different kinds of birds do not all build their nests together, but each kind has a separate place. Highest up are the nests of the black backed gulls, next below them those of the silver gull, and below them other birds, such as petrels, geese, and ducks. While the females are seated on the nests, the male birds perch near them and seem to try to amuse them with the clacking of their beaks and their cries.

In Australia is a kind of turkey called the brush-turkey, which piles up a large heap of decaying leaves, grass, etc. After the heap has become warm from the rotting of the vegetable matter, the brush-turkey digs a hole about two feet deep in the top, lays its eggs in it, buries them,

and leaves them to be hatched out by the heat. These mounds are always built like pyramids, and sometimes have in them many cartloads of grass and leaves. Another kind of bird builds high mounds of sand, grass, and leaves, and still another makes earth mounds sometimes more than twice as high as a man and buries its eggs deep in them.

Among other ground building birds are those called miners, which either dig deep holes in the earth for their nests or use burrows made by other animals. The kingfisher digs a crooked gallery, nearly as long as a man, in the side of a bank, and at its end makes a round hole in which it lays its eggs. The sand-martin lives in large families or colonies, which build their nests in holes about three feet deep dug in the side of a sand bank; and when the gravel is too coarse the holes are made deeper until fine sand is reached. The bird begins its hole by pecking away the sand with its beak, while it clings on to the outside of the bank with its sharp claws; but as soon as the place is large enough for it to get into it digs with its claws and brushes out the sand with its wings. At the end of the hole it makes a little round chamber and lines it with soft grass and feathers. The common petrel (see GULL) digs a winding burrow in the side of banks, but makes no nest in it, laying only one egg on the bare earth. Its burrow is sometimes very long, turning now this way and now that, and lastly coming back under the place where it began, and ending in a chamber nearly under the opening. The burrowing owl makes its nest in the holes of the prairie dogs on the plains of the West, and in the burrows of the ground squirrel in California.

Almost all the class of birds which include common fowls, turkeys, peacocks, pheasants, grouse, partridges, and quails make their nests on the ground. The wild turkey hides hers in tall grass, and covers up her eggs with leaves when she has to go off for food. The quail, the meadow lark, and other birds also hide their nests away beside tufts of grass, making a kind of arched covering over them. Most of the American sparrows nest on the ground, but the common house sparrow does not. Many of the larks, thrushes, and other small birds also build their nests on the ground.

Fig. 1.—Nests of Cliff Swallows.

The most wonderful birds' nests are those which are built in trees, bushes, and other places above the ground. Some of these are made of a kind of mortar plastered together by the birds' beaks; some are cut out by their sharp bills from the solid

wood of trees; some are ingeniously woven together from grass and hair, and hung from the branches of trees or set up in the crotches of limbs, and some are made of leaves sewn together as neatly as if done with needle and thread. Among the birds which build their nests of mortar, or moist clay, are the cliff and barn swallows of America and the house swallow of Europe. Cliff swallows build flask-shaped nests, like those shown in Fig. 1, formed entirely of mud and plastered against the side of high rocks or cliffs. Six or seven birds generally work at one nest, flying off in all directions and coming back with their beaks filled with mud, which they soften by working before plastering it on the nest. One of them, whom we may call the master-builder (while the others are only masons), sits inside the nest, smooths down the clay, and sees that the work goes on properly. The clay, when baked by the sun, becomes very hard. In wet weather swallows work very fast and soon finish their nests, but in dry weather they work only in the morning and evening, when the clay is moist. Barn swallows' nests are built in much the same way, but they are a little different in shape and the walls are usually knit together with bits of hay. They are plastered up under the eaves and against the rafters of barns, and sometimes even of dwellings. Beside the nest is almost always built a little platform or perch on which the male bird can sit and sing to his mate while she sits on the nest. It is said that when the season is to be cold the nest is nearly closed, with a hole just big enough to let the bird in, but that when the season is to be very warm the nest is open at the top all the way across.

Birds which cut holes in trees to build their nests in are called carpenter birds. The chief of these are the woodpeckers, whose sharp beaks peck away at the hardest living trees until a hole fit for the nest has been cut. A short tunnel, sloping upward, only large enough for one bird to go through at a time, is first cut, and then a larger hole is made downward in the middle of the tree, sometimes three or four feet deep. The eggs are laid at the bottom of this on the small chips that have fallen. Both the male and female birds work by turns at cutting these nests, seldom stopping until their house is done. In the plains of the West, where there are no trees, woodpeckers dig out their nests in earth in the sides of banks.

Eagles and some other birds build what are called platform nests, on

Fig. 2.—Nest of Magpie.

the tops of the highest trees. They are made of branches of trees and sticks woven together so as to form a nearly level floor, and so strong as to bear the weight of a man. On this, without building any nest, the eagle lays her eggs and hatches her brood. A few eagles, however, lay their eggs on the edges of high cliffs almost on the bare rocks. Pigeons also build platform nests of sticks so loosely laid together as scarcely to hold the eggs laid on them.

Many birds build rude baskets of sticks in the limbs of trees and then make a soft nest inside. The magpie, a sly and cunning bird, which

steals and eats the eggs and young of other birds, is very careful to guard its own nest by building a strong defence around it of sticks and thorns woven closely together, as shown in Fig. 2. Inside of this its nest is

Fig. 3.—Nest of Weaver Bird.

made of roots of plants, wool, and feathers, plastered together with mud. The mocking bird also builds its nest of fine woven roots inside of a wall of brambles and thorns. Among

Fig. 4.—Nest of Social Weavers.

the most curious nests are those made by the birds called weavers, among which are included the orioles and others. The Baltimore bird weaves out of several kinds of grass a kind of long round pouch, open at the top, fastening it to the branches of a tree, and sometimes weaving the twigs in with it. It is very curiously and strongly woven, the threads of grass being passed through and through as if with a needle. There are other kinds of weaver birds in Asia and Africa, one of which builds nests like that shown in Fig. 3, almost always hanging them from the ends of twigs and branches, and often over water. This is on account of the snakes and monkeys that abound in hot countries, and which are the greatest enemies birds have. The twigs which will bear birds' nests will not bear the weight of the monkey, who is too cunning to trust him-

Fig. 5.—Nest of Tailor Bird.

self on a slender branch which may break and let him drop into the water. There is another weaving bird in Africa, called the social weaver, a number of which club together and build an immense grass canopy like an umbrella (Fig. 4) in the top of a tree, weaving it so closely that it will shed water as well as a roof. Under this shelter each pair of birds build their own nest.

The tailor bird of India makes a still more curious nest than the weavers, for it actually sews the edges of leaves together, as shown in Fig. 5. After picking out a leaf large enough for its nest, it pierces

rows of holes along its edges with its sharp beak, and then sews it up into a bag with a long fibre of grass, which makes excellent thread. If the leaf is not large enough, it brings another one and sews it on to the first one in the same way. It is said that the tailor bird will even make a knot at the end of his thread to keep it from slipping through. The bag thus made is only the outside of his home, and after it is done he builds a warm downy nest within. The nest is always at the end of a limber twig, so that no mischievous animals can reach it, and as the outside is of the color of the other leaves it is quite securely hidden. There is another bird that sews, but which uses only short threads just long enough to go across once, and ties a knot in the end of each piece as it draws it through. This bird, called the fan-tailed warbler, is found in some parts of Europe.

BISMUTH, one of the ELEMENTS. It is grayish-white, crystalline, with a reddish tinge; is brittle and easily powdered, and is a bad conductor of heat and electricity. It is found usually mixed with metals, such as cobalt, nickel, copper, silver, lead, and tin. The principal places where it is got are South Australia and New South Wales, Sweden, Germany, Siberia, Bolivia, and the United States. Bismuth forms ALLOYS with most other metals; it toughens lead and makes tin more elastic and sonorous; and when added to both tin and lead it makes an alloy easily melted, which is largely used for electrotype moulds. In different forms bismuth is used in glass and porcelain staining, and in gilding porcelain; for making pearl white, used as a cosmetic; for making a fine yellow paint called antimony yellow, and in medicine.

The origin of the word bismuth is unknown.

BITUMEN, the general name of several kinds of mineral pitch or resin. They are all found in the earth or in rocks, or bubbling up from springs. Some suppose that they are vegetable in origin like coal, but they differ from coal in many ways. The common kinds of bitumen are: that which flows like oil, such as naphtha or PETROLEUM; that which is both soft and hard, being either pasty like pitch or hard as ASPHALT; and that like india rubber, which is soft and springy, and will rub out pencil marks. The last has been found only in three places in the world, in England, in France, and near Southbury, Mass.; but the oil and soft and hard bitumen are common in many countries.

In the island of Trinidad in the West Indies is a large lake of bitumen, a mile and a half round and covering about a hundred acres, which is hard enough to walk upon. There are celebrated bituminous springs near the site of ancient Babylon, from which the bitumen flows like oil, together with salt water, on which it floats. It is skimmed off and left in the air, when it grows hard. The Babylonians used this to make cement for building. There is also much bitumen along the Dead Sea in Palestine, supposed to come from springs at its bottom.

The ancient Egyptians used bitumen for embalming or preserving dead bodies; and this is what makes mummies so black and hard. It is now used for covering roofs and terraces, for all kinds of work under water, and for making walks and roads.

The word bitumen is from the Latin *bitumen*.

BLACKBERRY. The wild bush or shrub on which the blackberry grows is rightly named the bramble, and in England the fruit is commonly called the brambleberry. The raspberry bush has the same name, and they both belong to the rose family of PLANTS. The blackberry grows almost all over Europe and Asia, and in most parts of North America. In the United States are found the high-

bush blackberry, the low-bush blackberry, and the dewberry, all of which grow wild. There are several cultivated kinds, among which are those called the Lawton, the Dorchester, and the Wilson. There is also a kind the berries of which are white when ripe. The fruit of the cultivated kinds is larger and better than the wild fruit. Blackberries are eaten for dessert, and made into preserves, jelly, and jam. A kind of wine is also made from them.

The blackberry is not a real berry, but a collection of stone FRUITS.

BLACKBIRD. The bird commonly called blackbird in the United States is really a starling. In New England it is usually called the red-winged blackbird, because it has a patch of scarlet on each wing. This bird is found in summer nearly all over North America, living usually in swamps and low meadows. It builds its nest in May in low bushes or turfs of grass, and lays three to six white eggs marked with blue or purple. In the early part of the season it lives on insects and grubs, but when corn is ripening it eats the juicy grains and does some damage to the crops. Farmers then hunt blackbirds, and their flesh is very good eating.

The **Crow Blackbird** is the purple grakle, which also belongs to the starling family. It is a large bird, but not quite so long as a crow, and is blue-black with shadings of green and bronze. These birds are found from New England to Florida. In the spring they follow the farmer's plough and pick up grubs and worms, which would destroy a good deal of corn, but they also do some damage by pulling up corn. They build their nests in trees and lay four to six bluish-white eggs, with brown and black streaks.

The **European Blackbird** belongs to the thrush family. It is a fine singer, and, like all the thrushes, is easily taught. When wild it sings only from March to July, especially at night, but in the cage it sings nearly all the year round. Its memory is so good that it will learn to sing several tunes without mixing them, and it will sometimes even imitate words. The blackbird should be kept in a large cage by itself, as it will often peck smaller birds to death. It should also have plenty of fresh water, as it loves to bathe. It will eat bread crumbs, and both raw and cooked meat, and, in their season, likes cherries, elderberries, and other berries. This blackbird lays four to six pale green eggs, spotted with buff.

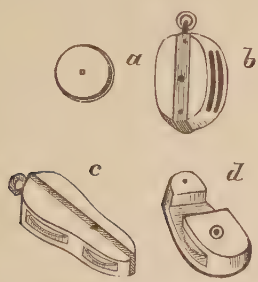
BLACKFISH. The common name of a fish found on the coasts of New England and New York. The Indians called it the *taut*; and it is now often called the tautog, which is the plural of the Indian word. The blackfish or tautog is a thick chubby fish, without any split in its tail, and has a slimy skin covered with small, hard scales. Its back and sides are black mottled with brown, and its lower parts are white. It is caught in rocky places near the shore, with lobster, crab, or clam bait, and is usually eaten broiled or baked. Blackfishing is very good sport in the spring and early summer.

BLACKING, a preparation for preserving or polishing boots and shoes, harness, and other leather articles. It is usually made of BONE or ivory black, which is mixed with oil, a little sugar or molasses, some vinegar or sour beer, and a little strong sulphuric acid. Sometimes a little gum arabic is put in. All the materials of blacking are ground together in a paint mill until the paste is smooth, when it is put up in the tin boxes in which it is usually sold. Blacking is sometimes made in a liquid form and put into bottles.

BLACK LEAD. This mineral is wrongly called lead, for there is no lead in it. Its proper name is graphite, but it is called also plumbago. It is grayish-black, soft, and greasy, and is usually found in lumps be-

tween layers of slate. The principal places where it is mined are Cumberland, England; Germany, Austria, Siberia, and Ceylon; and in the United States at Ticonderoga and Fishkill, N. Y.; at Sturbridge, Mass.; at Brandon, Vt.; and at Sonora, Cal.; That mined at Ticonderoga is almost pure carbon. Black lead is one of the forms of CARBON. It is generally found mixed with clay, lime, sulphur, and some iron. It is not affected by heat, cold, ACIDS, or ALKALIES, and it is a remarkable conductor of ELECTRICITY; as it is very hard to melt, it is mixed with clay in making CRUCIBLES or melting-pots, which have to stand great heat. All crucibles used now for melting brass, steel, copper, gold, silver, nickel, and other metals, are made of it. Another most important use is the making of lead PENCILS. Blacking for polishing stoves and grates is made from it, and it is used to dust the wax moulds in making electrotype plates (see PRINTING). It is also one of the best solid lubricants known, and is smeared on machinery and belts to keep them from wearing by rubbing.

BLOCK, a round box or case with a pulley or little wheel inside of it, much used in the rigging of ships



Blocks.

a, Sheave; *b*, Double Block; *c*, Long Tackle Block; *d*, Snatch Block.

for raising and lowering the sails, masts, yards, etc. In the article LEWIS is a picture of a block showing how it is used in drawing up a heavy stone, to which it is made fast by the lewis. The rope goes round the pulley inside the block, and as the pulley turns round like any other wheel it is much easier to pull the rope over it than if there were no wheel in the block. The case of a block, which is called the shell, is usually cut out of a solid piece of elm or other tough wood. The pulley, called by sailors the sheave, is generally of iron, but sometimes of LIGNUM VITÆ or other hard wood.

The shape of the sheave is shown in the picture in *a*. Some blocks are made with several sheaves in them, Thus, *b* is a double block, with two sheaves in it; and *c* is a long-tackle block, with two sheaves, one above the other. In *d* is shown a snatch-block, which has a notch cut through one of the sides of the shell so that the rope which goes over the sheave can be lifted in and out without the trouble of putting its end in first and pulling it through, as has to be done in the other blocks. The piece of iron around a block to fasten it in its place is called a strap,

The word block is *block* in German and *blok* in Danish and Dutch, and means a block or mass of anything.

BLOOD. In the article MAN it is told that everything in the body is made from the blood. By this is meant that the blood gives food to all parts of the body, and makes them strong enough to grow and do their work, just as the sap in plants gives life and strength to the stem, the branches, and the leaves. Thus the blood is the building material of the body, just as the sap is the budding material of the plant; and the blood in man and in other animals is made from the food which they eat, just as the sap of plants is made from the food which they suck up from the earth. You cannot see blood in food anymore than you can see sap in earth, and there really is no blood in food and no sap in earth; but the

stomachs of animals take from food what is needed to make blood, and the roots of plants take from earth what is needed to make sap. Blood is made from different things in different animals; the blood of the cow comes mostly from grass and other vegetable food, that of wild beasts from flesh, and that of man from both flesh and vegetable food. This is because the STOMACH is made different in each.

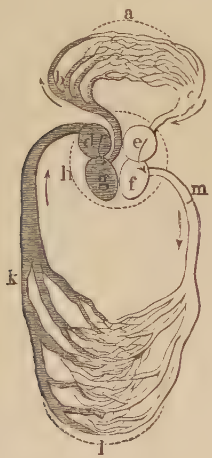
When fresh, blood will run like water, and it really has much water in it, but it is thicker than water, and is not clear like water. To the naked eye blood looks like a bright red fluid, but when looked at under a MICROSCOPE it is seen to be made up of little round flat red bodies floating in a clear fluid. These little red discs are so small that if three thousand of them were put together in a row, like a roll of coins, they would stretch along just about one inch. When one of them is looked at alone it is yellowish, but when many are seen together they appear bright red. All the color in blood is made by these red corpuscles, as they are called, corpuscle being from a Latin word meaning a little body. There are also a few white corpuscles in blood, but it is not necessary to tell about them here.

When blood runs out of the body of any animal, it soon becomes clotted or thick like jelly. If caught in a dish it will in a few minutes become so solid that when turned out it will keep its shape like a mould of jelly. But if left standing for a few hours it will separate into two parts; a thick part which has in it all the coloring matter of the blood, and a thin part much like the white of a raw egg; and this thin part is really much the same as the white of egg, for it is made up chiefly of ALBUMEN and water. Most people think that blood clots because it gets cool, just as jelly does, but this is not so. It will clot quicker if it be kept warm. It is hard to tell exactly why it clots; all we know is that while it is in the body of a live animal there is something which keeps it fluid, and that when it leaves the body it thickens.

When in the body the blood is always moving, carrying to the muscles, the brain, the skin, the lungs, the liver, the kidneys, and the other parts, the things which they need, and carrying away those things with which they have done. While the blood moves all those parts do their work, but when it stops they all die, starved for the lack of the things they need, and choked with the things they do not want. This movement of the blood is through the blood-vessels, of which there are two kinds, arteries and veins. The arteries are tubes which carry blood from the heart to all the parts of the body; and the veins are another set of tubes which carry the blood, after it has done its work, back to the heart again. These arteries and veins go into almost every part of the body; the arteries divide into many branches and grow smaller and smaller until each one loses itself in a network of tubes as fine as hairs, called capillaries (Latin *capillus*, a hair) which finally come together again and form a vein. To understand exactly how the blood travels through the arteries to all parts of the body and is then squeezed through the capillaries into the veins, through which it returns to the place it started from, ready to go round again, you ought to know all about the way the heart acts; but as this is hard to show without a heart to look at, I shall tell about it in as few words as possible.

The human heart is about as large as a man's fist, and is shaped something like the figure which we commonly call a heart. It lies in the body between the lungs, with the point slanting toward the left lung. It is a kind of bag with a network of MUSCLES wrapped round it, and is divided up and down into two sepa-

rate parts. Each of these parts is again divided crosswise, or nearly so, for the upper and lower parts connect with each other. Thus the heart is divided into a right half and a left half, and each of these halves is again divided, but not completely so, into two parts, making an upper and a lower chamber; so that in all there are four chambers, two upper and two lower ones. The two upper ones are called the right and the left auricle, and the two lower ones the right and the left ventricle. The right auricle opens downward into the right ventricle,



Circulation of the Blood.

and the left auricle opens in the same way into the left ventricle.

Now, by looking at the picture you will be able to understand just how the blood goes round, or circulates, as it is called. But you must remember that this does not show the circulation just as it is, but only the principle of it. If you had no arms nor legs, and only a few capillaries in your lungs and a few more in the lower part of your body, it might look something like this; but the capillaries are in all parts of the body, in the head as well as in the other parts. The picture, therefore, only shows the principle on which the blood works. In this the dotted line *h* stands for the heart; *d* is the right auricle, *g* the right ventricle, *e* the left auricle, and *f* the left ventricle. To see how, then, the blood goes round through the body, suppose that the right auricle *d* is full of blood. The blood first passes down into the right ventricle *g*, then upward into the lung arteries *b*, from which it passes through the lung capillaries and down through the great lung vein *c* into the left auricle *e*; it then passes into the left ventricle *f*, from which it passes down through the great artery *m*, called the aorta, from which it passes through all the other arteries and through the capillaries *l*, into the veins *k*, and then upward through the great vein into the right ventricle again. Thus the blood has travelled all the way round, after visiting by means of the capillaries all parts of the body, and come back to the right auricle, whence it started. So the blood has really two circulations, one through the lungs, marked *a* in the picture, and the other through the other parts of the body, marked *l* in the picture. The right side of the heart receives all the veins from the body and sends all its arteries to the lungs, and the left side receives all the veins from the lungs and sends its arteries all over the body.

You have thus learned that the blood is always travelling in the same way, from the right over to the left side, and then around to the right side again. The reason of this is that the heart is a kind of PUMP. You will remember that in the pump there is a little door called a valve which lets water pass through it one way but will not let it flow back again. It is the same in the heart; between the right auricle and the right ventricle is a valve which lets the blood flow through, but will not let it go back again; and there is another valve between the right ven-

tricle and the great lung artery, and two like ones on the left side of the heart.

I have said that the heart is a kind of bag divided into four parts and covered with muscles. These muscles are all the time at work, squeezing together these parts and then letting them go again. First the two auricles are squeezed up, both at the same time, and then, just as the muscles have done, the ventricles are squeezed up; then the muscles let go of the ventricles, and for a brief space the heart is quiet; the auricles then begin again, and so on, first one and then the other, all the time, night and day, while the body is alive. This squeezing up of the different parts forces the blood from one to the other, and keeps pushing it through the arteries and the veins until it comes round to the heart again. Thus the restless heart is all the time pumping and forcing the life-giving blood into all parts of the body, so that every bit of it is bathed by fresh blood. The beating of the heart may be seen and felt on the left breast. Many people think this is the pumping of the blood, but it is really caused by the striking of the point of the heart, which I have told you lies toward the left side, against the chest. When the muscles squeeze up the ventricles, the point of the heart is thrown a little forward, and gives a thump on the chest. When the blood flows through an artery, it goes in little throbs, caused by the pumping of the heart, there being always one throb to each heart beat. Doctors usually feel the throb of the artery in the wrist, and this is called feeling the pulse; but the pulse may be felt in any part of the body where there is an artery; for example, on the temple or on the inside of the ankle.

The blood which goes through the arteries looks different from that which passes through the veins. Blood taken from an artery has a bright scarlet color, while blood from a vein is of so dark a purple that it is called "black blood." There is one exception to this. In the arteries which go to the lungs the blood is dark, and in the veins which come from the lungs the blood is light. This will be seen by looking at the picture, where *b* shows dark blood going through arteries to the lungs, and *c* red blood coming through veins from the lungs. This is because the dark blood has to pass through the lungs to become changed to red blood.

Scarlet blood is commonly called arterial blood, and black blood venous blood. The principal difference between them, besides their color, is that arterial blood has more OXYGEN and less CARBONIC ACID in it than venous blood. In the article LUNGS is told how every breath of AIR which is breathed in gives oxygen to the blood; and in the article STOMACH is told how the blood takes up the good parts of the food which we eat. Now, the greater part of this food is CARBON, which is needed to supply fuel to the body, just as the carbon in wood and coal is needed for the fuel of an engine; and as the carbon in wood and coal is burned by uniting with the oxygen of the air, so the carbon of the blood is burned by uniting with the oxygen which the blood takes in through the lungs. Wood and coal give off heat in burning, and heat is the power which causes the engine to move; food also gives off heat in burning, and this heat too is the power which gives our bodies strength to do what we want them to do.

Now, let us go over this once more, so that it may be thoroughly understood. The food which goes into the stomach is there digested, and the good parts pass into and become part of the blood. The blood, driven by the heart's pump, is forced through the arteries and into the capillaries, by means of

which it reaches almost every part of the body; and, as it is also drawing oxygen from the air every time it goes round through the lungs, it is thus always carrying through the arteries fuel to burn, and oxygen to burn it with, to muscles, bones, nerves, brain, and skin. Burning is, therefore, going on in all parts of the body, and thus the arterial blood, which is rich in oxygen, is changed into venous blood, which has but little oxygen in it. From most places where this burning is going on the venous blood goes away the hotter for it, and all this hot blood carried through the veins keeps the body warm and gives it the power and the strength to act. Every part of the body is wearing away little by little, and is being made anew by the blood. The same blood makes different things in different parts; the bones and muscles get strength from it, and the brain and nerves power to feel. The arterial blood, in thus refreshing and building up every part of the body, loses its oxygen, which unites with the carbon and forms carbonic acid; and this is the reason why it is dark-colored when it goes back to the heart through the veins. It is then pushed again through the lungs, where it loses its carbonic acid and takes in more oxygen, and goes down into the left side of the heart and becomes arterial blood once more.

There is also some other waste matter in the blood besides carbonic acid which has to be got rid of. Much water passes off through the lungs when we breathe, and a good deal also and various SALTS pass off from the blood through the skin as perspiration. Urine also, which is made up chiefly of water, ammonia, and salts, comes from the blood through the kidneys. The kidneys are little bundles of long tubes bound up in a round mass. Small blood-vessels lead to these, and as the blood passes through the urine dribbles into these little tubes, which unite into a larger tube that leads into the bladder.

Thus the impurities of the blood pass off chiefly through three channels: the lungs, the SKIN, and the kidneys; but it is possible that some waste things are used up in other parts of the body, for the waste of one part is not exactly like the waste of another.

Sometimes when a person has lost much blood from sickness or accident, some of the blood of a healthy person is squirted into his veins. Not enough is taken from the healthy person to hurt him, and the other is often made well by it. It was once thought that the blood of a sheep or other animal might thus be used, but it is now known that the blood must be of the same kind as that with which it is to be mixed. About four hundred years ago a physician tried to save the life of Pope Innocent VIII. by putting into his veins the blood of boys; but it was so carelessly done that three boys, from whom the blood was taken, died, and the Pope was not helped any.

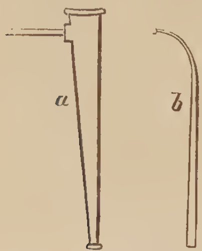
The Old Testament forbids the eating of blood, and therefore the Jews eat only the meat of animals killed by being bled to death.

The word blood is from the Anglo-Saxon *blōd*.

BLOWPIPE, a tube for blowing air across the flame of a candle, lamp, etc. It makes a pointed flame which is very hot, and which may easily be turned upon anything so as to heat it. The blowpipe marked *b* in the picture is one much used by jewellers. A better form is the one marked *a*, which is a tube about eight inches long, small at the top, where the mouth-piece is, and wider at the bottom, which is closed. Near the bottom a small pipe, with a fine pointed end, leads out of it. When this small end is put into the flame of a candle and the tube is filled with air by blowing or breath-

ing into it, the flame is blown out into a long point which is much hotter than common flame. This is because more OXYGEN is thus blown into the flame than it would commonly get from the air. The blowpipe is used in soldering metals by jewellers and gold and silversmiths, and by chemists, and others. The glass-blower's blowpipe is told about under GLASS.

The **Oxy-hydrogen Blowpipe** is used when a very great heat, much greater than can be got in any other way, is wanted. This is made of two



Blowpipes.

tubes, one inside of the other. The inner tube is joined to a gas-bag filled with OXYGEN, and the outer one to a gas-bag filled with HYDROGEN. The hydrogen gas is first turned on and lighted at the end of the tube, and then the oxygen is slowly let on, both of the bags being pressed with a weight so as to force the gas through the pipes. The two gases mix together at the end of the tubes where they are lighted, and blow the flame out into a fine point, which is so very hot that almost anything can be melted in it.

BLUEBIRD. The bluebird is found only in North America. In the United States it flies northward in early spring and is one of the first birds to appear in New England after the snow begins to melt. For this reason it is always welcomed as the messenger of spring. It spends the winter in the Gulf States and in Mexico.

The bluebird is bright sky-blue above, and yellowish-brown below. Its song is a soft, full warble. It usually builds its nest near a house in some sheltered place, such as a hole in a tree, or a rail-hole in a fence-post. It also likes a little box like a martin box, and will often fight with the wrens for one. It lays five or six pale-blue eggs, and hatches several broods in a season. When the nest is attacked by snakes or other animals both the male and the female will defend it with great courage. Bluebirds live mostly on insects in summer, and on cedar berries and fruits in autumn. They may be easily tamed, and they make very pretty pets.

The bluebird belongs to the order *insessores*, or perching BIRDS, and to the warbler family. It gets its name from its color.

BLUEFISH. This fish is sometimes called horse-mackerel and sometimes skipjack. The bluefish is usually one to three feet long, and is bluish black on the back and whitish below. It comes along the coast of the Middle United States in the spring, following the weakfish and mackerel, on which it feeds, and is caught during all the summer months and until late in the autumn along the New England coast. It is a very greedy fish, and may often be seen chasing the mackerel, springing out of water, and following them so closely as to drive many on shore. It also feeds largely on sand eels. It will bite at almost anything moving quickly through the water, and is usually caught by trolling behind a sail-boat a line fitted with a squid, or piece of lead or bone made like a fish, and a hook. The bluefish snaps at it, thinking it to be a small fish, and gets caught on the hook. Sometimes a thing called a spoon is used instead of a squid. This is usually silver-plated, and is made hollow like the bowl of a spoon, which causes it to whirl round and round when drawn through the water. When a

bluefish is hooked the line must be drawn in quickly and steadily, for this fish is so strong and lively that it will often run ahead and unhook itself. In the last of summer and in the fall the bluefish is very fine eating.

The bluefish belongs to the same family with the MACKEREL. It gets its name from its color.

BLUE JAY. The blue jay is found only in America. It sometimes stays all the year round in New England, but usually goes south in autumn. Its color is purplish-blue above and whitish below, with lighter blue wings, and tail marked with black bands and in some places tipped with white. On its head is a beautiful blue crest. The blue jay is noisy, mischievous, and quarrelsome. It is a great scamp, and robs the nests of other birds of their eggs and young, and when these fail it steals from the farmer's crib. Its usual note is a harsh scream, but it is a great imitator of voices and sounds. It seems to take great delight in frightening other birds by screaming like a sparrow hawk and then wailing like a little bird in pain. The negroes in the Southern States believe that the blue jay is the agent of the devil, and that it carries to him all sorts of slanderous stories about colored people. They therefore take great delight, whenever they catch one, in wringing its neck.

If taken from the nest when quite young the blue jay may be easily tamed. It will become much attached to its owner, and will readily learn to talk, but not so well as the parrot. It is very vain of the few words it speaks, and likes to show off before strangers.

The blue jay belongs to the order *insessores*, or perching BIRDS, and to the crow family. It gets its name from its color.

BOBBIN, or **SPOOL,** a little roller with raised ends, to wind yarn or thread upon. Bobbins are largely used in spinning and weaving. In laying the warp threads for making CLOTH, the threads are first wound upon bobbins. The little reel or spool in the SHUTTLE, on which the weft thread is wound, is a bobbin. The bobbins used in making bobbinet LACE are usually made of iron. The spools or bobbins on which cotton thread is wound for the retail trade are turned on the bobbin LATHE, from little blocks of hard wood. A boy feeds it by dropping the blocks into a kind of box called a hopper and the machine turns them and drops them out one by one, all finished, at the other end. It will make fifteen hundred spools in an hour.

The word bobbin is in French *bobine.* Its origin is unknown.

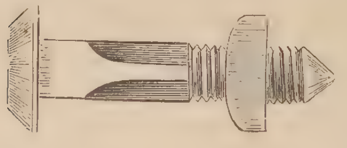
BOBOLINK. This bird is found only in America; it passes the winter usually in the West Indies, and comes northward in the spring, travelling mostly by night, reaching New England in May. At this time its plumage is black, varied with a little yellowish-white on the rump and tail feathers, and with a patch of brownish-yellow on the back of the neck. Bobolinks live in cool, grassy meadows, which they make cheerful with their merry song, made up of a mixture of short notes sung so quickly that it sounds as if a dozen birds of different kinds were singing all together. The female makes her nest of dried grass on the ground, and lays five or six purplish-white eggs, blotched with darker purple, and spotted at the larger end with brown. While she is sitting the male bird flits about and cheers her with its song. Toward the end of June the bobolink ceases singing and changes its suit of glossy black for one of rusty brown, its lower parts becoming dull yellow. It now flies away to the banks of the Delaware and Schuylkill rivers, where it feeds on the seeds of the wild rice and gets very fat. In that part of the country it is called the reed bird, and is much

hunted by sportsmen. Later, in September and October, it goes to the rice fields of the South, where it grows so fat that it can scarcely fly, and when shot will often burst open as it strikes the ground. In the Carolinas it is called the rice bird, or rice bunting, and it is highly esteemed for eating. Still later it appears in Cuba and other of the West India Islands, where it fattens still more on the seeds of the guinea grass, and is called the butter bird.

The bobolink may be tamed, if taken when young from the nest, and it makes a very pretty and sprightly pet, but it will sing only in spring and summer. It may be treated in the same way as the canary, whose notes it will quickly learn.

The bobolink belongs to the order *insessores*, or perching BIRDS, and to the finch family. The name bobolink or bobolincoln, as it was formerly called, is an imitation of the bird's notes.

BOLT, a strong pin, usually of metal, used to fasten or hold something in place. A common bolt is much like a large nail or spike, only it is generally round. In ship-building many kinds of bolts are used; they are usually of iron or of copper, and differ in size from a few inches



Bolt and Nut.

to several feet in length. Some of the longest ones, used for bolting together very thick and heavy timbers, are as large round as a man's wrist. These long bolts are usually fastened in by clinching—that is, by hammering down the end so that it cannot be pulled back again through the hole, or by driving a plug of iron through a hole in the end.

A **Screw-Bolt** or tap-bolt is a bolt with the end made like a screw, which holds it firmly in its place. It has no slit across the head for a screwdriver, as in a common screw, but has to be screwed into wood by means of a WRENCH.

A **Bolt and Nut** is a bolt which is fastened in place by a movable piece called a nut, which is screwed on to the end. The one shown in the picture is a kind used in making ploughs. The screw itself does not hold on to the wood, as in the screw-bolt, but is meant only for the nut; and when the nut is screwed on the bolt really has two heads. Such bolts are much used by carriage-makers and stove-makers, and also by railroad and bridge builders. The fish-plates which hold the ends of rails on RAILROADS are fastened with bolts and nuts.

The word bolt is Anglo-Saxon, and formerly meant a short arrow used in a cross-bow. The iron bolt was probably so called because its shape is something like that of the cross-bow bolt.

BOMB. See SHOT and SHELL.

BOMBAZINE, a kind of twilled CLOTH having a silk warp and a worsted weft. Black bombazine is worn by ladies for mourning. It is made mostly at Norwich, in England.

The word bombazine is from the Latin *bombycinus*, silken, which is from the Greek *bombux*, silk.

BONE, the substance of which the skeleton of most ANIMALS is made. Bone is chiefly made up of GELATINE, a kind of colorless and tasteless jelly; of phosphate of lime, which makes more than half its weight; and some other earthy matter. If bone be soaked in weak ACID all the earthy matters will be taken out leaving only the gelatine, which will be of the same shape and size as the bone, but will be soft and elastic or springy. If, on the other hand, bone be burned in a hot fire all the gelatine will be burned

and only the earthy matter will be left; this will at first keep the form of the bone, but the least touch will make it crumble to dust.

Bones are largely used in the arts, being worked up into handles for knives and forks, tooth and nail brushes, combs, buttons, etc. When burned in an open fire and ground, bones are made into bone ash, which is largely used for manure. When carefully prepared, bone ash is called burnt hartshorn, and is used for cleaning jewelry. It is also used for making PHOSPHORUS for tipping matches.'

Bone Black, sometimes called animal charcoal, is a black powdered charcoal, made by burning bones in a close vessel called a retort and then grinding them fine. It has the power of taking all the color out of most liquids, and leaving them clear as water. It is much used for refining the syrups of sugar, and for taking the impurities out of water and other liquids. It has the power also of absorbing or taking up most odors, especially bad smells, and is used to purify rooms, clothing, etc.

Bone Dust, obtained by grinding bones, is largely used as a manure. Plants take up from the soil certain salts, which are sometimes returned as ASHES. When animals eat grasses and plants, the salts in them are made into bone. Hence when the bones of animals are ground up and put upon the land as manure, some of the salts are returned to the soil from which they were taken.

The word bone comes from the Anglo-Saxon *ban*.

BOOK. Paper like that which is now used was unknown in ancient times. The Egyptians wrote on a kind of paper called papyrus, made from the inner bark of the papyrus plant, which grew in Egypt, and this came into general use in all countries. Parchment, made from the skins of sheep and calves, furnished a more lasting writing material, but its cost was much greater. Books of papyrus and of parchment were generally made in one long, narrow piece, and wound around a wooden roller, just as a wall map is rolled up. When unrolled these books were sometimes several hundred feet long. Books of this kind were used by the Greeks and Romans, and by all other ancient peoples, but they had also books made of wood, ivory, bronze, and other materials, and these were generally square or oblong like our books, and were made of sheets or leaves bound together. This more convenient form at last came into use everywhere, and since the invention of printing nearly all books have been made in this shape.

There are many sizes of books. A common sized school reader is a 12mo, or, as it is called in Latin, a duodecimo; the next larger size is 8vo, or octavo, and then follow 4to, or quarto, and folio. The next smaller size to 12mo is 16mo, then 18mo, then 32mo, and then 36mo. When these names were first given to books they were used to mean the number of leaves into which the sheet of printing paper was folded in making a book. For example, a sheet folded once, so as to make two leaves, was called a folio; folded twice, making four leaves, a quarto; and folded three times, eight leaves, an octavo. But these words now mean rather the size of the page than the number of folds in the sheet. Folio and quarto books are not easy to handle, and are now seldom printed; the most common sizes are 8vo for large works, and 12mo and 16mo for small books.

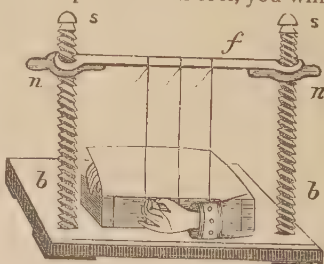
The making of a book properly begins with the author who writes it. The book as it comes from the writer's hands is called a manuscript. It should be written only on one side of the sheet, because it is handier for the printer who sets up the types. When the manuscript is done, the next step is to publish it,

that is, to have it printed, bound, and brought before the public. Authors sometimes publish their books themselves, but it is customary for a publisher to do this for them. Every author has by law a right to share in money made from the sale or use of his books during a certain number of years. This right is called a copyright. He may either sell all his copyright to the publisher for a sum of money, or he may sell it for a certain part of the profits. This is the usual way. The publisher now puts the manuscript into the hands of the printer, to be printed. (See PRINTING.) A very few publishers have printing offices of their own, but most of them have their printing done somewhere else. The number of copies of a book printed and published at one time is called an edition. An edition is usually one thousand copies. When the book comes from the printer it is in large flat sheets printed on both sides. Up to about 1885, a 12mo book printed to contain twenty-four pages on each side of the sheet, so placed that when the sheet was cut in half and folded, the twenty-four pages on each half would come in the right order. Of late presses have been built so large that most books of the 12mo size are printed thirty-two pages on each side of a sheet.

The book is then sent to the bindery to be bound, that is to have the covers put on. The sheets are first taken to the sheet-room, where they are folded, gathered together, and sewed. A 12mo book of four hundred and eighty pages, printed twenty-four pages at a time, will take ten sheets of paper. The same book printed 16mo, or thirty-two pages at a time, will take seven and a half sheets of paper, the paper for a 16mo being a third larger than that for a 12mo. When the 12mo sheet is folded it forms a little pamphlet of twelve leaves or twenty-four pages. The 16mo sheet is usually printed to fold in four signatures, of sixteen pages each. Sometimes in cheap publications the entire sheet of sixty-four pages is so printed that it folds in one signature, thus making a considerable saving in folding and sewing, but the book is not nearly so strong and does not open as well as when the sheet is divided into four sections. The folding of the sheets in small editions is usually done by girls. A girl can fold about three hundred sheets in an hour; but folding machines are now largely used which fold twelve hundred sheets an hour. When the sheets are all folded they are piled on the gathering table, all of each signature being in one pile.

A person called the gatherer then walks round the table, picking up one from each pile, until he has all the signatures of a volume collected in the right order in his hand. The volume thus gathered then passes to another person called the collator, who examines the signatures to see if they are in proper order, and then puts them evenly together. The volume is now pressed tightly in the smashing machine, and five little grooves or channels are sawed across the back. These grooves are cut to receive the cords or bands to which the sheets are to be sown.

If you will open this book and look at the top or bottom of it, you will see



Sewing-bench.

that it is made up of a number of small parts. Each of these parts is a signature. The girl who sews the book has before her a frame called a "sewing-bench," like that shown in the picture, up and down which are tightly

stretched three pieces of strong twine, just wide enough apart to fit into the three middle cuts in the back of the book. The girl piles up a number of books beside her and then takes up the first signature and holds it so that the pieces of twine, which are called the bands, are closely pressed into the cuts. She then passes her needle through the upper cut and down the middle of the signature, passing under the bands at each of the three middle cuts, thus fastening the signature firmly to the bands. The other signatures are fastened to the bands in the same way, and when all are sewed the bands are cut above and below the signatures, leaving about an inch of the twine on each side. These ends are afterward pasted to the covers of the book, thus strengthening the binding. You can probably see little ridges caused by them on the inner edges of the cover. Many books are now sewn by machines, which do the work faster than it can be done by hand.

After sewing the book goes to the forwarding room, where the front edge is cut smooth in a machine. The back is then beaten round by a hammer and smeared with glue, so as to hold the parts firmly together. The two ends are now trimmed smooth in a machine, and the book is ready for the cover. The cover is made of two pieces of thick pasteboard, called millboard, and is usually covered with muslin fastened on with glue. The lettering and ornamenting on muslin covers are done before the cover is put on to the book. They are stamped on by means of metal DIES in a machine made for the purpose. If the cover is to have gilded figures on it, the gold leaf is laid on first in a sheet with a little sizing or thin glue; it is then pressed with a hot die, which stamps its form on it, and the rest of the gold leaf is then brushed off. The cover is next fastened on with paste, and the book is then pressed until dry. Books bound with morocco and other costly materials are done in a somewhat different way. After the book is finished it returns to the hands of the publisher, who sells it and gives the author his share of the amount of the sales.

The word book comes from the Anglo-Saxon *boc*, which is from *béce*, beech tree; and it was so called because beechen boards were used to write on.

BORAX, a SALT formed of boric ACID and carbonate of soda (SODIUM carbonate). Boric acid, also called boracic acid, is made up of an ELEMENT called boron united with HYDROGEN and OXYGEN. Much boric acid is brought from Tuscany, where it comes out of cracks in a volcanic mountain in a white vapor or steam. The vapor is made to bubble through water as it rises, and is thus mixed with it, and the liquid is then boiled down until the water passes off in steam, leaving the acid in hard, clear crystals something like common salt. This boric acid is afterward mixed with the alkali carbonate of soda, and the two unite and form the salt called borax. Borax is also found native, that is, by itself, in many countries, but the chief supply in commerce comes from Thibet, Asia Minor, Italy, Chili, Bolivia, and the United States.

The largest deposit of borax in the world is in California, where it was discovered in 1856. It is so pure that it is only necessary to shovel it into wagons and cart it away. Almost all the borax used in the United States comes from there. There are several deposits in Inyo, San Bernardino, and Lake counties. There are large deposits also in Esmeralda and Churchill counties, Nevada, and others in Oregon.

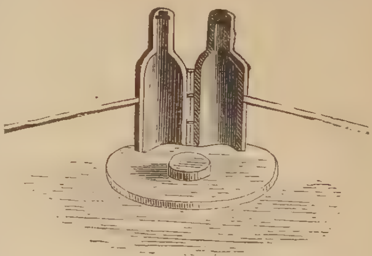
Borax is a colorless salt, with a greasy feel, and a smell like soap. When heated it melts into glass, which mixes easily with the oxides (see OXYGEN) of metals, and be-

comes colored by them. For this reason it is much used for making ENAMELS, artificial or false gems, and paints and glazes for pottery. It is used also in soldering gold, brazing copper, welding iron, in enamelling metals, especially in making mantle-pieces to represent marble, and many similar industries. It is also valuable for cleansing, and is used instead of soap in washing the gum out of silk, instead of soda in washing clothes, and in cleaning the hair. Cockroaches do not like it, and may be driven away from houses by scattering it where they are. Laces, muslin, tulle, and other light fabrics are made fireproof by being steeped in it. It is used in glazing paper, in curing and preserving skins, in dyeing leather, by pork and meat packers for preserving, and by fish curers for keeping fish fresh.

The word borax comes from the Persian *burah*, borax.

BOTTLE, a small, hollow vessel, made usually of glass or earthenware. In ancient times bottles were made of the skins of animals, mostly goats; and such bottles are still used in Spain and Italy for carrying wine, and in Asia and Africa to carry water in. The ancient Egyptians had bottles of earthenware, glass, ivory, alabaster, and different metals.

The ancients made their GLASS bottles by blowing them with a blowpipe, a hollow iron tube about five feet long. The end of the blowpipe was dipped into the melted glass, and enough taken up to make one bottle. The glass-maker then blew gently through the tube, which swelled up the glass like a soap bubble, and while it was still soft shaped it with an iron tool. Bottles are now sometimes made in the same way, but they are usually pressed in a mould. The hot glass is taken up at the end of the blowpipe, and the blower then rolls it round and round on an iron table, called a marver, blowing gently through the tube at the same time. As soon as he thinks it is shaped right, he puts it into a mould like that in the picture. After closing the two parts, he blows gently through the blowpipe, which forces the soft glass into every part of the mould, and causes it to take the print of any letters or figures engraved on the inside of it. The mould is then opened, the bottle taken out, and an iron rod called a punty is fastened by a little melted glass to its bottom. By touching a cold iron or a wet stick to the end of the neck it breaks off from the blowpipe, and the bottle then passes to



Glass Bottle Mould.

the finisher. The finisher has a bench with two arms to it. He lays the punty across these arms and turns the bottle round and round by rolling it with one hand while he forms the neck of the bottle with the other. Several kinds of tools are used to shape the mouth. After it is done the bottle is taken off from the punty and put into an oven, where it is heated almost hot enough to melt, and then allowed to cool slowly. This, which is called annealing, toughens the glass and makes it less apt to break.

The word bottle is from the French *bouteille*.

BOW. Before it was found out how to make gunpowder, bows and arrows were used in war and in hunting instead of guns. We read about them in the Bible, and pictures of them are engraved on many ancient monuments. In old times battles

were usually begun by shooting arrows, which were fired by soldiers called bowmen or archers, of whom there were sometimes many thousand in one body. The bows used were very large and strong, and the arrows had sharp points made of iron or copper. They were shot with such force that they often went clear through the body of a man or a horse. Soldiers wore iron armor and carried shields on their arms to protect themselves against them, but arrows sometimes went through both armor and shields.

Among modern archers, the English were the most famous, and many of their battles were won by their skill with the bow and arrow. In early times shooting matches were held, where prizes were given to the best shot, just as in our rifle matches; and many wonderful stories are told of the skill of some of the marksmen. The English bow, usually called the long bow, made of yew or ash wood, was about six feet long. The arrows, which were of ash, were a yard long, or half as long as the bow, and were tipped with steel and feathered with goose feathers. The long bow was so much liked as a weapon by the English that it was used in their armies even in Queen Elizabeth's time, when the gun had taken its place almost everywhere else.

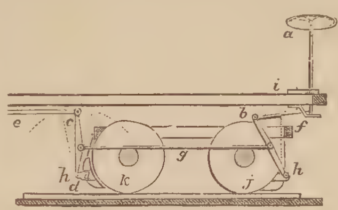
Bows and arrows are now used only by savage peoples, like the North American Indians, or as playthings. Another kind of bow, called cross-bow or arbalast, was used also in former times. In this the bow, which was much shorter than the long bow, was fixed across the end of a stock like a gunstock.

The word bow comes from the Anglo-Saxon *boga*, a bow.

BOX, a hard kind of wood, much used by wood engravers and turners. The box tree is an evergreen, with shining, deep-green leaves, In Asia and in Southern Europe it often grows more than three times as high as a man. Its wood, which is light yellow, is very tough, heavy, and fine-grained, and takes a fine polish. It is the best of all woods for wood engraving, and it is also used for making fine rules, and flutes and other musical instruments. Large quantities of it are brought from Turkey, the Greek islands, and Spain. The dwarf box grown in gardens is a kind of the same tree.

The word box is Anglo-Saxon, and comes from the Latin *buxus*, Greek *puxos*, the box tree.

BRAKE, a machine for stopping a wheel, or for making it turn slowly, by pressing a rubber against it. Brakes are sometimes used on loaded wagons, to check them when going down hill; but their chief use is on railway cars. The common



Common Railroad Brake.

brake is made up of a block or rubber made to fit the outside of the wheel, a lever, one end of which is made fast to the block and the other to a chain, and a WINDLASS on the platform of the car to wind up the chain. The way in which it works is shown in the picture, where *a* is the windlass on the platform of the car. When the brakeman turns the windlass, the chain is wound up around the shaft. This shortens the chain, and pulls forward the upper end of the iron bar *b*, which presses the brake-block *h* against the car wheel *j*, and at the same time pulls the iron rod *g*, which pulls the iron bar *c*, and presses the brake-block *d* against the car wheel *k*. Thus the two brake-blocks are pressed hard against the two wheels, and this

tends to stop them. At the same time, in pulling the rod *c*, the rod *e* is also pulled, which presses other brake-blocks against the wheels of the next truck (see RAILROAD); and there are like rods and other brake-blocks on the other side of the car, so that when the windlass is turned all the wheels are pressed and the car is thus stopped by friction, or by the rubbing of the blocks against them.

In the **Creamer Brake** the blocks are pressed against the wheels by the power obtained from a very strong spring, coiled up in a round box at the bottom of the windlass on the platform of the car. The brakeman can use it by turning the windlass, or it can be worked by pulling the rope in the car.

The **Westinghouse Air Brake** is worked by the elastic power of compressed AIR contained in an iron box on the engine. Under each car is a round iron barrel about the size of a small keg which is joined by pipes with the iron box on the engine. When the engine driver wishes to stop the train, he opens a VALVE, which lets the compressed air rush from the box into the barrels. This forces out a piston in each cylinder (see STEAM ENGINE) and these act upon all the blocks on the wheels of the cars at once, and stop the train very quickly. The Westinghouse brake is the one in most general use on railways; but the Eames Vacuum Brake and the Boyden Automatic Air Brake are used on some roads.

The word brake is probably from the Anglo-Saxon *brecan*, to break, to break the force of anything.

BRANDY, a liquor made out of grape wine by distillation. (See ALCOHOL.) It is usually about half alcohol and half water. In the United States brandy is made out of the fermented juice of fruits, like the cherry, peach, pear, and apple. Apple brandy is sometimes called cider brandy; and pear brandy, perry. All these brandies differ from brandy made from wine only in the flavor given to each by the fruit from which it is made. Wine brandy when first made is white, but it becomes colored by the wood of the cask. This color, which grows deeper as the brandy grows older, is sometimes made in new brandy by putting burnt sugar into it. The best brandy is made in France, but little of it is pure. A great deal of WHISKEY is sent from the United States to France, where it is made into a false brandy and sent back here for sale.

The word brandy was formerly brandy-wine. It comes from the German *Branntwein*, burnt wine, which is made up of *brannt*, burnt, and *wein*, wine, meaning wine distilled.

BRASS, an ALLOY of copper and zinc. It is usually made of two parts of copper and one part of zinc, but sometimes more copper is used, and sometimes a little tin and lead are added. Brass is largely used for the ornamental parts of machinery, the pipes of organs, tubes of telescopes, stair rods, buttons, pins, tacks, screws, etc. It is sometimes used also instead of bronze for statues, because the tin in bronze makes it more costly. Pinchbeck, oreide, Mannheim gold, tombac, and other alloys that look like jewellers' gold, are kinds of brass, as they are made principally out of copper and zinc. Brass was known in very ancient times, and is supposed to have been worked even before iron.

The word brass is from the Anglo-Saxon *braes*.

BRAZIL NUT, the fruit of a large tree found chiefly on the Orinoco River in South America. The nuts are three-sided, with hard dark-brown shell, and the meat, which is all in one piece like an almond nut, is white inside and covered with a thin dark skin. When fresh they are very good to eat, but as they have much oil in them they soon spoil. This oil is sometimes pressed out for use in lamps.

Brazil nuts grow on the tree in a smooth round case, half as large as a man's head. Inside of this the three-sided nuts are packed closely together, with the sharp edge inward, somewhat like the parts of an orange, as many as twenty or thirty being sometimes in one case. It is dangerous to pass under the trees when the fruit is ripe, as the nut cases, which are heavy enough to break a man's skull, are apt to fall, Sometimes the cases burst open when they strike the ground, and this is at once the signal for an amusing scramble among the monkeys, who swing themselves down from branch to branch by the help of their tails, and fight furiously for the nuts, of which they are very fond. The monkeys, too, often pick the cases and throw them down to break them. This has taught the Indians how to get the nuts; they pelt the monkeys with stones, and the monkeys hurl down the cases full of nuts at them. In this way large quantities are collected on the banks of the Orinoco, and brought down the river in boats.

The Brazil nuts are so called because most of them are brought from Brazil.

BRAZIL WOOD, a red dyewood used in dyeing silks. The tree from which it is got grows in the West Indies and in Brazil, but most of the wood is now brought from Brazil. Only the heart of the tree is used for dyewood, the rest being of no value. The red dye is got by boiling the wood in water. It makes a very fine red, but is not very lasting. By using ACIDS and ALKALIES, shades of orange, yellow, violet, and purple are made from it. It is also used for making red ink. An African wood called camwood, brought from Sierra Leone, is now much used instead of Brazil wood.

The word Brazil is from the Portuguese *brasil*, perhaps from *briza*, a fragment, because the wood was imported in pieces. The country of Brazil gets its name from the wood, because a great many of these trees are found there.

BREAD. Of all FOOD bread is the most important, and it is used in some form in almost every country in the world. It is made principally from wheat, although rye, barley, oats, Indian corn, and rice are much used in it. In Africa it is made sometimes of the pith of the sago palm, in Southern Europe of ground chestnuts and acorns, in Lapland of a kind of moss, and in South America of the seeds of a kind of pine tree. In the South Sea Islands the BREAD-FRUIT, and in the West India Islands the banana, are largely used instead of bread.

The best bread is made from wheat FLOUR. In the most ancient times the grain was merely pounded in a mortar or between two stones, and then wet with water and baked before a fire. Such bread was not raised or spongy, but was solid and hard. It was called unleavened bread, because it had no leaven or YEAST in it. If you look at a slice of wheat bread, you will see that it is full of little holes which prevent its being solid, hard, and tough. Such bread is called leavened or raised bread.

The way of making leavened bread by raising it with yeast was early found out, it is supposed, by the Egyptians. In making bread the flour is first worked into a paste with about half its weight of water; a little yeast is then added, and the dough is put for several hours into a warm place to rise. This is caused by fermentation, which is told about in the article BEER. The yeast causes the sugar in the flour to ferment, and changes it into ALCOHOL and CARBONIC ACID. The alcohol passes off as steam into the air, but the carbonic acid works its way all through the dough in little bubbles of gas, which are kept in by the sticky GLUTEN of the flour, and the whole mass rises or becomes puffed

up with it. When it is light enough the dough is worked again with some salt, made into loaves and baked in an oven. The carbonic acid gas swells with the heat during the baking and bursts out, leaving the little holes which we always see in bread.

As long as fresh bread is warm, fermentation is going on, and as this makes bread hard to digest, it is best not to eat it until it is cold, Baked bread always weighs more than the flour; a pound of flour will make about a pound and a quarter of bread. Bread made from rye or barley is as good for food as wheat bread except that it does not digest so easily. Aerated bread is made without yeast by mixing the flour with water which has carbonic acid in it. Baker's bread is not so wholesome as home-made bread because poorer flour is generally used, and alum and other unhealthful things are put into it to make it white. Graham bread is made from wheat flour, out of which the pieces of shell of the grain, which are called bran, have not been bolted or sifted. It is much eaten by people with weak stomachs.

The word bread comes from the Anglo-Saxon *bread.*

BREAD-FRUIT, the fruit of the bread-fruit tree, a native of the Pacific Islands. The tree is handsome, with leaves a foot long and ten inches wide, and grows twenty to forty feet high. The fruit, which is like a green melon about a foot long, and marked on the outside with a diamond pattern, is gathered when nearly ripe and baked in ovens in the ground. The crust is taken off and the inner pulp, which is much like bread made with eggs, is eaten; or it is washed and packed in the earth for future use. In this way it will keep good several months. If the fruit is left on the tree until ripe, it becomes sweet and tastes more like clammy cake than bread. The natives also mix it with cocoa-nut milk to make pudding. The bread-fruit, with the cocoa-nut and banana, furnishes the chief food of the natives of the Pacific Islands. The inner bark, when beaten out, forms a fine, white cloth, called tapa cloth.

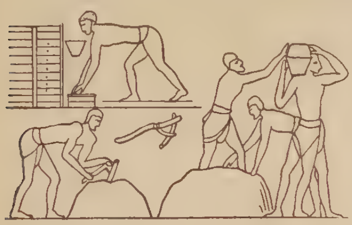
The bread-fruit tree was first made known by the voyages of Captain Cook, and soon afterward the British government sent Captain Bligh to Otaheiti to carry some to the West India Islands. It now grows well there and in most other hot countries.

BRICK, a building material made of clay, moulded into blocks, and burned. The clay, if too rich, is mixed with a little sand or ashes, which keeps the brick from cracking. It is then ground in a mill until it is soft like putty, when it is moulded into the right shape in a little box with a loose bottom, so that when the sides are lifted up the brick is left on the bottom. This is the old way, but bricks are now more commonly moulded by a machine forming a part of the mill which grinds the clay, and which will make about twenty thousand bricks in a day. After being moulded the bricks are well dried in the sun and then piled up loosely in great stacks called kilns, with holes under them to build fires in, and flues left open up to the top, so that the heat and gases of the fire will pass freely through the whole pile. It once took about two weeks to burn a large kiln of bricks, but some makers now mix the dust of anthracite coal in the clay, and thus burn them in three or four days. Bricks in a kiln are not all burned alike, some being baked too much and some not enough. Those not burned enough are put into the next kiln and baked again.

Bricks are not usually red until they are burned; their color comes from the oxide or rust of iron, which is rusted more by fire. If the clay has not much iron in it, the bricks will be lighter in color. Milwaukee

bricks, which have no iron in them, are cream-color. Building bricks are usually two inches thick, twice as broad as they are thick, and twice as long as they are broad. Fire bricks are made of kinds of clay that will not melt in fire, mixed sometimes with ground stones. They are used to line furnaces and stoves with, and are moulded in the proper shapes to fit the places where they are to go.

Bricks have been used for building from the most ancient times. The walls of Babylon were built of bricks laid in BITUMEN. The Egyptians used sun-dried bricks, made of clay mixed with chopped straw. The Israelites were employed in brick-making during their bondage in Egypt. The picture shows brick-makers digging clay and moulding



Egyptian Brickmakers.

bricks. The Greeks and Romans made excellent bricks; the Romans made great use of them, and some of the bricks in their buildings have lasted better than the stone used with them. The Chinese make bricks with a face like porcelain. (See POTTERY.) Many bricks are now moulded in handsome designs and are used in architectural decorations; and some are chiselled like stone into ornaments after they are put up in buildings. The sun-dried bricks of which houses are built in California and Mexico are called *adobe* bricks.

The word brick is in French *brique*.

BRIDGE, a roadway over a stream, a valley, or low ground. A bridge for carrying a canal or water to supply a city is called an AQUEDUCT (water-leader); one over which a railway passes is sometimes called a viaduct (road-leader). The first bridges were made of wood by laying beams from one bank of a stream to the other, or, when these were too

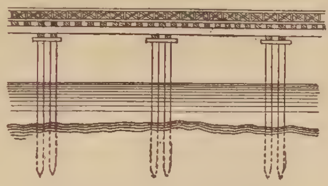


Fig. 1.—Pons Sublicius.

wide apart, resting them on posts or stone piers in the middle. The Chinese built bridges at a very early date, but it is supposed that the Romans were the first to make stone bridges, and some of them, more than a thousand years old, are still in use.

The first bridge built at Rome was called the Pons Sublicius (*pons*, bridge, and *sublica*, a wooden stake or pile) or wooden bridge. It was built by Ancus Martius, and rebuilt by the chief priests, who from this got the name of Pontifices (bridge-builders). This bridge, shown in Fig. 1, was the one defended by Horatius Cocles (See C. P. P., PORSENNA). Julius Cæsar's bridge, thrown across the Rhine in ten days,

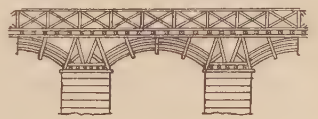


Fig. 2.—Trajan's Bridge.

was also of wood. Trajan's bridge, built across the Danube, was a wooden structure resting on twenty piers of hewn stone. The picture (Fig. 2) is from the bas-relief on Trajan's Column at Rome. The Pons Milvius, now Ponte Molle, one of the earliest stone bridges at Rome,

was built 100 B. C. The Pons Ælius, a stone bridge built by the Emperor Hadrian, 130 A. D., is now called the bridge of St. Angelo. The Romans built many fine bridges in different parts of Europe, sometimes adorning them with a triumphal arch and sometimes with a castle for their defence.

Old London Bridge, a stone bridge across the Thames, built at the close

Fig. 3.—Old London Bridge.

of the twelfth century, was covered with three-story timber buildings, used both as houses and shops. The houses were often burnt and rebuilt, but the main bridge stood until the beginning of this century, when the new London Bridge was built. The illustration (Fig. 3) shows it as it was in 1616. The famous Bridge of the Rialto, Venice, was built in 1588 by Antonio da Ponte. The space of the arch is 91 feet, the height above the water 24 feet 6 inches, and the width of the footway 72 feet.

There are many splendid stone bridges in Europe, but few of much size in the United States. The finest are the High Bridge of the Croton Aqueduct, over the Harlem River, and the Starucca Viaduct on the Erie Railway. But the United States have the best wooden bridges in the world. These are made of timbers put together in such a way as to brace and support each other. The bridge over the Susquehanna River at Havre de Grace is three-fifths of a mile long. The bridge over the Delaware on the Erie road, that over the Susquehanna near Columbia, and those over the Connecticut River are also remarkable.

As wooden bridges are apt to catch fire, those made of iron and steel are now taking their place on railway lines. Among the most wonderful of these are the wrought iron bridge over the Menai Strait, called the Britannia Bridge, and the Conway Bridge, both in Great Britain, and the Victoria Bridge over the St. Lawrence River at Montreal. These are all what are called tubular bridges, being made of great iron tubes or pipes, through which railway trains run. The Victoria Bridge is a huge square iron tube, two miles long, held up over the river on great stone piers. Some of the finest iron and steel railway bridges in the United States are those over the Mississippi River at St. Louis, at Rock Island, near Quincy, and near Dubuque; over the Missouri at Omaha; the Parkersburg Bridge, West Virginia; and the Henderson Bridge over the Ohio. The longest iron bridge in the world is that over the Tay, near Dundee, Scotland. It is nearly two miles long, has 89 spans, and its roadway is 88 feet above the water. In 1879 twelve of the middle spans fell during a gale at night and an entire railway train was lost, not a person out of more than 90 being saved. It has since been rebuilt. The Washington Bridge across the Harlem River, New York, a splendid steel structure, built in 1889, has two steel arches of 510 feet span, 133 feet above the water.

Cantilever Bridges. A cantilever or cantaliver in architecture means a bracket projecting from the wall of a building to support a balcony, eaves, etc. A cantilever bridge is one having long brackets or arms projecting toward each other from opposite banks or piers. Sometimes these two arms meet in the middle and are fastened

together; but generally, they are joined by a third piece called a girder. Each cantilever generally rests on one pier and has its shore end firmly fastened to another. One end of the central girder is fastened to one cantilever, and its other end, which is fitted with rollers, rests only on the other cantilever, so that it may contract or expand without danger. The principle of the cantilever bridge is old. The picture (Fig. 4) shows a bridge of this kind at Wandipore in Thibet, built about 1650. The brackets, fastened to piers of masonry at each end, are joined in the middle by a girder. The first cantilever bridge in this country, at Niagara Falls, was built in 1883 (Fig. 5). A large cantilever bridge connects Louisville and New Albany across the Ohio River, and another crosses the Hudson River at Poughkeepsie. The Memphis bridge, now building (1893), the first across the Mississippi below the Ohio, has one span of 790 feet and two of 621 feet each. The largest and most remarkable cantilever bridge in the world is that across the Firth of Forth in Scotland, built in 1883–91. Its entire length, with its approaches, is a mile and five-eighths. There are two spans of 1710 feet, two of 685 feet, fifteen of 168 feet, and other smaller ones. The main spans are formed by three immense double cantilevers resting on three piers, making the road bed 150 feet above the water. The bridge is higher than St. Peter's church at Rome.

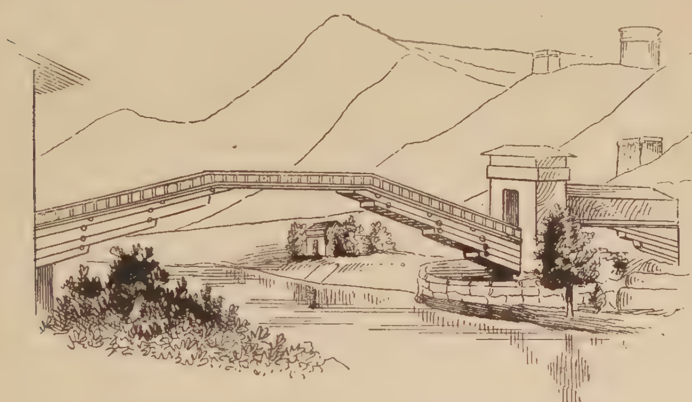


Fig. 4.—Cantilever Bridge at Wandipore in Thibet.

Suspension Bridges. Among the most remarkable bridges are those not held up from below but hung on some kind of ropes or chains, and called therefore suspension (Latin *suspendere*, to hang) bridges. The Chinese built this kind of bridge out of iron chains in very ancient times, and the Peruvians made them out of bark ropes. Modern suspension bridges are built of large and strong cables, made out of many small wires twisted together. The great bridge over the East River, from New York to Brooklyn, built in 1870–83, is suspended by four such cables, each as thick as a very large man's waist (16 inches). It is 5989 feet, or more than a mile and a tenth long. The span over the river, between the towers, is 1595 feet 6 inches, the longest of any suspension bridge in the world. The piers are 278 feet above high water, and the roadway 135 feet above the water, so that steamboats and ships can pass under it. The

roadway, which is 85 feet wide, has passages for cable-cars, vehicles, and foot passengers. A much larger suspension bridge is proposed to be built across the Hudson River at New York. It will be 6500 feet long and will have a span of 2850 feet, or nearly twice as long as that of the Brooklyn bridge. Other sus-

Fig. 5.—Cantilever Bridge at Niagara.

pension bridges in this country are those over the Ohio River at Wheeling and Cincinnati, and that at Niagara Falls. Among the finest in Europe are that at Fribourg in Switzerland, and that over the Danube at Pesth.

Movable Bridges. Bridges are sometimes made so that they can be moved in order to let a vessel pass. These are of various kinds: drawbridges are made to raise and lower; swing or turn bridges, to turn round on a pivot; and rolling or sliding bridges, to roll backward and forward on little wheels or rollers. Bridges that are to be used for only a little while, like those built by soldiers in war time to cross rivers, are sometimes made by fastening many small boats together and building a floor over them. Casks and rafts have also been used for the same purpose. Military bridges are usually supported by floats called pontoons, made of frames of timber covered with copper, tin, leather, tarred sail-cloth, or India-rubber cloth, or of copper cylinders. The pontoons are laid from bank to bank and securely fastened, and the bridge platform is then laid upon them.

The word bridge comes from the Anglo-Saxon *bricge*.

BRIMSTONE. See SULPHUR.

BROADCLOTH, a fine kind of woollen cloth, so called because it is wider than other cloths (56 to 60 inches). It is woven very closely, and has a smooth shiny surface. It was once largely used for men's coats, and still is, especially for evening dress; also for ladies' cloaks.

BROCADE, a silk stuff, sometimes woven with gold and silver threads, so as to show gold and silver figures on it, and sometimes woven with all silk, so as to make a beautiful pattern of raised flowers, foliage, and other figures. Brocade is now seldom made with gold and silver threads, because they lose their brightness so easily. It is used mostly for curtains and for covering furniture, but sometimes for ladies' dresses.

The word brocade is from *broccato*, the Italian name of this cloth, which is from a word meaning to embroider.

BRONZE, an ALLOY made by mixing copper and tin, to which zinc and lead are sometimes added. Gun metal, from which cannons are cast, contains about nine parts of copper and one part of tin, and bell metal about three parts of copper and one part of tin. Modern French bronze, out of which most of the small bronzes sold in the stores are made, contains about nine parts of copper, and one part made up of a mixture of zinc, tin, and lead. In making bronze the copper is first melted in the furnace, the tin and other metals are then put in, and the whole is stirred until it is well mixed. (See STATUE.)

As bronze costs a good deal, many imitation or false bronze ornaments are made, which look like real bronze, but are much cheaper. Many figures and other small ornaments for mantels and many gas-fixtures are made of it. They are usually cast in ZINC or some other cheap metal, and covered with a

kind of paint or varnish, which gives them the look of bronze. Ornaments made of wood, clay, and plaster are also sometimes bronzed in this way. But some cheap ornaments are covered with a coating of real bronze or copper

In old times, before it wask nown how to use iron, all kinds of tools and weapons were made of bronze, and that time is called by historians the bronze AGE. The ancients knew how to harden bronze so that swords. knives, axes, chisels, and other tools made of it would cut as well as steel ones; but we do not know how they did it.

The word bronze comes from the Italian *bronzo*, which is perhaps from *bruna*, brown. But some think it comes from Brundusium, a town in Italy, now Brindisi, where it was made.

BROOM, a brush for sweeping floors, so named because it is usually made of the broom corn plant. The broom corn plant grew first in India. It is said that Dr. Franklin planted a single seed, which he took from a whisk of broom corn brought from England, and that from it have sprung all the broom plants now in this country. The plant, which grows more than twice as high as a man, looks somewhat like Indian corn; but the head or brush, from which brooms are made, is much larger than that of Indian corn. Broom corn bears no ear, the seeds being all on the brush. The brushes are cut off when ripe. leaving about six inches of stalk on each, and are freed from the seeds by means of a machine called a "scraper," which scrapes them off without hurting the broom corn. The seed is fed to horses and poultry, and sometimes, when ground into meal, to cattle.

Brooms are made in this country mostly by the Shakers. The handles are usually of soft maple wood turned round in a LATHE. The twine for tying the broom is wound on a roller. The end of it is fastened to the broom handle, one end of which is cut down smaller than the rest, and as the broom corn is laid on the whole is turned so that the twine winds round and fastens it. Layer after layer of broom is put on, the twine winding round each one, until the broom is large enough, when the twine is cut and fastened. The broom, which at this stage is round, is now pressed out flat and sewed with twine to keep it so. Whisk brooms are made in the same way.

The word broom is from the Anglo-Saxon *brom*.

BRUSH. Most brushes are made of bristles, the long, stiff hairs which grow on the neck of the hog. Bristles, great quantities of which are sent from Russia and Germany to other countries, are of many colors and sizes. Brush-makers first sort them according to color, putting the black, brown, gray, yellow, and white ones in different piles. The whitest ones,which are called "lilies," are used for making tooth brushes. Each color is then sorted again by pushing the bristles through a row of steel teeth, like a comb, which catch the coarse ones; by passing them through several such combs, each finer than the other, the bristles are all separated into different sizes.

Many brushes, such as hair and clothes brushes, are made by drawing bunches of bristles, which are bent in the middle, through holes in a stock, or handle made of wood, bone, or some other material. This work is mostly done by women, who sit round a table, on the edge of which the stock is held tight by a CLAMP. Each woman has a lap full of bristles, and in her right hand a piece of fine brass wire. She makes a loop in the wire and pushes it down through one of the holes; then taking some of the bristles in her left hand she lays them in the loop, which she next pulls back through the hole. The bristles are thus doubled up and held by the wire,

When all the holes have been filled the ends of the bristles are clipped even with shears. A back piece is then glued on, which covers up the wires and the bristles and holds them tight. In some hair brushes there is no back piece; the holes are bored not quite through the stock, and the bristles fastened in with wire and glue. Tooth brushes have no back piece, but the bristles, which are bent and put into holes as in hair brushes, are held by wires which are put through little holes made from the end. If you look at the end of a tooth brush, you will see where the little holes have been stopped up. In some tooth brushes slits for the wires are cut in the back; after the wires are fastened the slits are filled up with red sealing-wax.

In making large paint brushes, the bristles are gathered into a bundle around the small end of the handle (thus leaving the large end sticking out of the front of the brush), and tied tightly with twine. The brush is then set on a board with a hole in it, through which the handle is driven till the large end of it is in the middle of the brush. This tightens the strings which hold the hairs. The back of the brush is then covered with glue.

Small paint brushes, used by artists, are made of the hair of the camel, badger, sable, squirrel, and other animals. Enough hairs to make one brush are tied together and then passed point first through the large end of a quill, which has been softened by soaking in water, until the point comes far enough out of the small end. When the quill dries it becomes smaller and holds the hairs tight. Such brushes are sometimes called pencils.

The word brush is from the Anglo-Saxon *byrst*, a bristle.

BUCKSKIN, the tanned skin of the deer, the male of which is called a buck. After tanning it is dressed by what is called the oil process; all the rough parts of the skin are cut off and smoothed, and it is then dried and rubbed full of a mixture of oil and tallow and laid aside until this soaks in. It is next rubbed with a board until it is soft and pliable. Buckskin is much used for polishing silverware and jewellery, and for rubbing furniture. In old times short breeches were often made of it, and were therefore called "buckskins." Most of the so-called chamois or "shammy" leather now sold is buckskin, and not the skin of the chamois, as its name would pretend.

BUCKWHEAT, a kind of grain from which buckwheat flour is made. The plant grows wild in northern China and southern Siberia, whence it spread into India and western Asia. It was brought into Europe through Tartary and Russia in the Middle Ages, and was first cultivated in Germany in the first half of the fifteenth century. It spread into western Europe in the sixteenth century. The French call the grain *blé sarrasin*, Saracen wheat, because it was first thought to have been taken to Spain by the Saracens or Moors, but it did not grow in their countries; others say because the grain is dark-colored like a Saracen. It is much valued as a crop in France, Germany, and the United States. A white flour is made from its grain, which in Germany is made into gruel, in France into bread, and in the United States into breakfast cakes. The grain is good food for horses and poultry. In England it is much used for feeding pheasants.

The word buckwheat is from the Anglo-Saxon *boc-hwæte*, beech-wheat, which is made up of *boc*, beech tree, and *hwæte*, wheat. The plant was so called because its grains are shaped like beechnuts.

BUFFALO, the name commonly but wrongly given to the wild cattle of North America, which are not buffaloes, but bisons. The true

buffalo is found only in India and in South Africa; but the name has been given so long to the American bison that it will probably always be called a buffalo, and his hide a buffalo robe. There were once, on the great plains of the West, immense herds of buffaloes, that wandered from one part of the country to another in search of pasturage, water, and salt springs. With the coming of winter they usually went southward, and in the spring returned again to the north, making wide paths over the plains for hundreds of miles. As they were too clumsy to cross mountains they sought the easiest routes; and emigrants found out the best

American Buffalo.

passes through the Cumberland and Rocky mountains by following buffalo trails. Even as late as 1871 buffalo herds one hundred and twenty miles long were seen on the plains, and they travelled so closely packed together that trains on the Kansas Pacific Railway were blocked by them and sometimes even forced off the track.

Great numbers of buffaloes perished during the spring and autumn travellings: many starved, many got weak and were attacked and eaten by wolves, and hundreds were often drowned by breaking through the ice in crossing frozen rivers. The Indians and white huntsmen too killed thousands for their hides alone, out of which buffalo robes were made. Some Indian tribes lived almost entirely on the buffalo: its flesh gave them food, its skin clothed them and covered their tents, and on the great prairies its dried dung was their only fuel.

Hunting the buffalo was very exciting and sometimes dangerous sport, for the animal was not easily killed unless shot through the heart or some other vital part. Though it runs with an awkward kind of gallop, it takes a good horse and rider to keep up with it. When wounded only it will turn and attack its hunters with fury, and even a skilled horseman often finds it hard to keep out of its way.

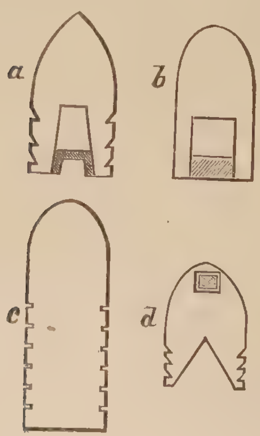
The buffalo once ranged over about a third of North America, from the Atlantic coast to beyond the Rocky Mountains, and from Mexico to the bleak northern region west of Hudson's Bay. By 1830 it had been driven west of the Mississippi; and in 1869 the completion of the Union Pacific Railway divided the great herd into two parts, a northern and a southern herd. After this the slaughter, which had been going on many years, became greater than ever before, and large hunting parties were sent out to kill buffaloes for their hides. Between 1872 and 1874 more than three and a half millions of the southern herd were killed, and in 1875 the remainder, only about ten thousand, fled to the wild parts of Texas, where they were gradually hunted down until 1880, when the hunting ceased. The northern herd numbered more than a million and a half in 1870. The Sioux Indians killed many of these, but in 1880, when the Northern Pacific Railway was opened, they were hunted just as the southern herd had been, and by 1883 few were left. In 1886 the United States Government sent Mr. W. T. Hornaday and others to the West to get specimens for the National Museum in Washington before it was too late; and in 1889 it was reported that only about a thousand (1091)

American bisons, wild and tame, were then living in all the world. Of these about 200 are wild in the Yellowstone Park, where they are preserved by the government; about 85 are running wild in other parts of the United States; and 254 are kept captive in parks in various places. There is also a herd running wild in Athabasca, in British North America, supposed to number about 550. There are said to be only seven tame ones in foreign countries.

The buffalo is a mammal of the order *ruminantia*, or cud-chewing animals, and belongs to the family of the *bovidæ*.

The word buffalo is from the Spanish *búfalo*, which comes from the Latin *bubalus*, the wild ox, from the Greek *boubalos*, a kind of African antelope.

BULLET, the ball fired from a gun, rifle, or pistol. Bullets are usually made of lead. In old times bullets were made by pouring melted lead into moulds, but they are now made by a machine which can stamp out of solid lead six or seven thousand in an hour. Bullets were formerly made round, but since the RIFLE has taken the place of the musket, they have been made long and generally sharp-pointed, and some have a hole in the back end with a plug fitted into it, which is driven in when the gun is fired and causes the lead to fill up the grooves or creases of the barrel. In the picture *a* is a Minié ball (named from its maker, a Frenchman) cut through the middle so as to show the hollow and the plug, which is a little iron cup. The creases or grooves on the side are usually filled with tallow. In the Enfield bullet, *b*, formerly used in the British army, the plug is a little piece of hard wood. The ball used in the United States Springfield rifle, shown in *c*, has no hollow in it. Sometimes bullets are made with a hollow place in their point, as in *d*, and filled with a kind of powder called percussion powder, which goes off when they strike any hard thing, and blows them to pieces. As all modern military rifles have much smaller bores than those formerly used, bullets are now made correspondingly small. Those used in the new English, German, and French rifles are more than three times as long as they are wide. They are all cased too in some metal harder than lead, the German bullets with German silver, the French with nickel, and the English with steel.



Rifle Bullets.

a, Minié; *b*, Enfield; *c*, Springfield; *d*, Explosive.

The word bullet is from the French *boulet*, a small form of *boule*, ball.

BUNTING, a thin woollen stuff, from which flags are made. It is made of a fine hard-twisted worsted thread, and is much lighter and stronger for the purpose than any other kind of cloth would be. It is made in all colors, and in making a flag the different colors are sewn together. The origin of the word is uncertain.

BUOY, a float chained to the bottom in harbors, rivers, etc., to show

where the channel is, or to mark the place of rocks, shoals, or other things beneath the surface. Buoys are made of wood or iron usually, and are of different shapes and colors, so that they can easily be told from each other by sailors. Buoys made of wooden logs, chained so that they stand up in the water, are called spar buoys, and hollow ones of iron or other metal, can buoys. Bells are sometimes fastened to buoys, so that the waves will ring them; and sometimes lanterns are hung on them.

The word buoy, in Dutch *boei*, and in French *bouée*, is from the Latin *boia*, Greek *bœios* (*bous*, ox), meaning a leather collar or fetter; hence a buoy is a thing fettered or fastened.

BURDOCK, a common wild plant, found almost all over Europe and the United States. It grows about a yard high, has large coarse leaves and a purplish flower. The little leaves around the flower-head have long sharp prickles, hooked at the point. By means of these the flower-heads, which are commonly called burs, catch on the clothes, the wool of sheep, the tails of animals, etc., and thus the seeds are scattered. In some countries the roots and the young shoots of burdock are used in soups. The leaves and their juice are good for putting on to burns, and on the skin when poisoned with poison ivy. The word burdock is made up of bur and dock, and means a dock that bears burs.

BUSHEL, a measure for dry materials, such as grain, vegetables, and fruit. It contains 4 pecks, 8 gallons, or 32 quarts. The bushel in use in the United States is the Winchester bushel, so called because the standard was long kept at Winchester, England. It was used in England from the time of Henry VII. (1497) until the time of George IV., when the imperial bushel, which is a little larger, was adopted. It takes 33 Winchester bushels to make 32 imperial bushels.

The word bushel is in old English *buschel*, old French *boissel* or *bussel*, from new Latin *bustellus* diminutive of *buxida*, from *pyxis*, a box.

BUTTER, the fatty part of MILK. Milk from which butter is to be made is set away in pans for about twenty-four hours, when the cream is carefully skimmed off. Cream is made up of the little balls of fat with which milk is filled, each one being covered with a thin skin called ALBUMEN. All that is needed to make butter is to break the albumen skins and let the fat run together. This is usually done by churning—that is, by working a wooden dasher through the cream until all the balls are broken. There are many kinds of churns, but the ones most in use are tall jars or casks in which the dasher works up and down, or boxes in which the dasher is turned round by means of a crank. Churning usually takes about three-quarters of an hour. The butter forms first in kernels and then into a mass, leaving a thin liquid called buttermilk. When the butter is taken out of the churn it is carefully washed in water, and then worked with the hand until all the buttermilk is got out, when salt is put in and it is made up into rolls for use. A little carrot juice or ANNOTTO is sometimes added to give it a brighter color.

Butter was but little known to the ancients. It is said to have been first found out by carrying milk in skin bottles on a camel. The butter was made by the jolting. It is still made in many parts of South America by putting the cream into gourds or skin bags and slinging them across the back of a donkey, and then making the donkey trot round until the cream is churned. In Buenos Ayres a goat-skin bag full of cream is tied to one end of a long leather rope called a lasso, and the other end is tied to the saddle of a horseman, who rides at a gallop with the bag bumping and jumping along on the ground behind him, until it is churned to but-

ter. In India a kind of butter called ghee is made from the milk of buffaloes.

The word butter is from the Anglo-Saxon *butere*, which is from the Latin *butyrum*, Greek *bouturon*, (*bous*, cow) butter.

BUTTER-FISH. This salt water food fish is sold in all the northern markets, and is liked by some better than the scup. It is caught along the Atlantic coast from Cape Cod to Cape Henry. It is a summer visitor, coming and going about the same time as the mackerel. The butter-fish is about 7 or 8 inches long, and is noted for the bright rainbow tints of its scales, which, in those freshly caught, are as beautiful as those of the dolphin. It is sometimes called harvest fish in New Jersey, dollar fish in Maine, sheepshead and skip-jack about Cape Cod, and pumpkin seed in Connecticut.

BUTTERFLY. Butterflies are the most beautiful of all the insects. Though they are much like moths in shape, they are easily told from them by the knobs on the ends of their antennæ or feelers, and by the greater brightness of their colors. They fly also only in the daytime, while moths fly by night. The greatest beauty of butterflies is in their wings, of which they have four, and which are colored on both sides, while in moths only the upper side is colored. Butterflies' wings are separate from each other, and they do not fold up when the insect rests, but stand straight up so that more of the under part can be seen than of the upper. The wings are covered with a kind of dust or powder, which, when looked at under the MICROSCOPE, is seen to be made up of many beautiful scales or feathers, as perfect as the coverings of fishes and of birds. They are so very small that it takes several hundred thousand of them to cover a square inch.

Butterflies live mostly on the sweet juices of flowers, around which they may often be seen fluttering in the sunshine. They have a long, hollow proboscis or tongue, which, when not in use, is coiled up under the head, as shown in the picture. When they wish to get the honey in the deep cup of a flower, they straighten this out, thrust it down into the flower, and suck the honey up through it. The two long things standing up above the head are the antennæ or feelers.

Like most other INSECTS, butterflies pass through three different stages or changes of life. The female lays her EGGS on the leaves of such plants as the CATERPILLAR usually feeds on, and leaves them to be hatched by the heat of the sun, Those laid in summer are sometimes

Proboscis of Butterfly.

hatched in a few days, but in cool countries eggs laid in autumn are often not hatched until the next spring. The caterpillars hatched in spring live as caterpillars during the greater part of the summer, and those hatched in summer live through the winter as caterpillars.

The picture shows the changes in the life of a butterfly: *a* is the full-grown larva or caterpillar, the form in which it is hatched from the egg, *b* the change called the pupa or chrysalis, and *c* the full-grown butterfly. This is a very beautiful kind of butterfly, common in Europe, which is called the "swallow-tail," from the points on its tail. The caterpillar is green, with black rings dotted with red, and the wings of the butterfly

are yellow, spotted and striped with black, with blue and red spots like eyes on the hinder wings. There are many kinds of swallow-tailed butterflies in the United States, one of the finest of which is black, with two rows of yellow dots on its back; on the wings are a broad band of yellow spots near the edge, with a row of small yellow spots outside, and on each hinder wing are several blue spots between the rows, and an orange spot with a black centre which looks like an eye. The caterpillar is yellow, striped and spotted with black. This butterfly is seen in New England and New York in June, when it lays its eggs, and from these a new brood of butterflies appear in August.

Butterflies are found in all parts of the world, even in the coldest countries during their brief summer, but the most kinds and the largest ones live in hot countries, where there are some which measure a foot across the wings. About five thousand kinds are known, of which nearly a thousand are in the United States. Though butterflies live only

Changes of the Butterfly.

a, Larva, or Caterpillar; *b*, Pupa; *c*, Imago, or perfect Butterfly.

a short time, they sometimes fly great distances, often in large flocks miles in width, and so long that they are many hours and even days in passing. Where they come from and where they go to are not known. In Australia is a kind of butterfly which is used for food by the savages. They fly in such masses among the granite cliffs of the mountains that great numbers of them are killed by the smoke of fires which men build against the rocks. Bushels of them are collected and baked; the wings are picked off and the bodies made into cakes which look like lumps of fat.

The butterfly belongs to the order *lepidoptera*, or scale-winged INSECTS.

The word butterfly comes from the Anglo-Saxon *buterflege;* and the insect is so called from one of the yellow kinds, which looks like butter.

BUTTERNUT, the fruit of the butternut or white WALNUT tree. The nuts are oblong, round at the base, and sharp at the point, and about two inches long. The inside or kernel is sweet and pleasant to the

taste, but contains so much oil that it is apt to spoil. The shells and the bark of the tree make a good brown dye.

Butternut wood is not so hard as that of the black walnut, but it is much used in making furniture as a contrast to it, as it is of a good yellow color and fine grain. Gun-stocks are also sometimes made of it. The tree is quite common in the north parts of the United States and in Canada.

The butternut gets its name from its richness.

BUTTON, an article for fastening or ornamenting clothing. The principal kinds of buttons are: those with shanks or loops, those with holes, and covered buttons. In making shank buttons of metal, the button and the shank are first made separately by machines, and then soldered together by hand. Some metal buttons are flat and some are hollow. The hollow ones are made of two separate disks or round pieces, both of which are stamped out by punching machines, which make the raised pattern and letters on them. The shank is first fastened to the under piece, which is a little smaller than the upper one. The two pieces are then laid together and put under a machine which laps the edges of the larger piece all around the lower one and holds it tight. The buttons are then polished, and sometimes silvered or gilded.

Pearl, bone, and ivory buttons are often made with shanks. The disks are first cut out with a tubular saw, that is, a tube with one end made into saw teeth. The saw is made to turn round rapidly in a lathe, and a thin sheet of pearl shell or bone is pressed against it until a round piece is cut out. After the edges have been smoothed, a hole is made half way through the under side, and then cut so as to make it larger at the bottom than at the top. The stem of the shank is made so that it will just go into the top of the hole, and then when struck with a hammer will spread out and fit tightly into the space at the bottom. Horn buttons also are sometimes made with shanks, but the disks are not sawn out: the horn is first softened by heat and then cut into disks with round punches.

Buttons with holes through them are made of many different materials, such as pearl and other shells, bone, ivory, vegetable ivory, various kinds of hard wood, vulcanized india rubber, glass, porcelain, etc. The best shells for buttons are brought from Macassar in the East Indies, but many are got from the Red and the China seas, and from the coasts of the West Indies and Central America. Pearl buttons are cut out with a tubular or pipe-shaped saw, after which the holes are made. Buttons made of porcelain are pressed in moulds and baked. Many girls are employed in sewing buttons on to cards.

Covered buttons are made by very ingenious machines, but the process would be too hard to describe. You can best understand how these buttons are put together by taking one to pieces. The first covered buttons were made of wooden moulds over which the covering was sewed, but they are now made of iron moulds or shells, which are in parts, so that when they are stamped together in a die the covering is firmly fastened and a part of the lining is pressed up through a hole in the under disk to make a tuft to sew it on by.

The word button is from the French *bouton*, a bud or button.

BUZZARD. This bird belongs to the FALCON family, but it is heavier and slower in its flight than the true falcon. It is as large as the eagle and looks much like it. It does not fly very high, but sails along with a mournful cry, looking for prey, such as hares, squirrels, mice, frogs, lizards, and small birds, on which it

chiefly feeds. When it sees any game it usually lights on a tree near by, and then swoops down quickly upon it. Farmers sometimes call it hen-hawk, because it visits poultry yards to steal chickens, but the hen HAWK is another bird. The turkey buzzard is not really a buzzard, but a kind of VULTURE.

The buzzard belongs to the order *raptores*, or BIRDS of prey.

The word buzzard is from the old French *busard* or *busart* which is from the Latin *buteo*, a buzzard.

C

CABBAGE. Wild cabbages grow on the rocks by the sea-shore in many parts of western Europe, but they have no heads; the heads of our garden and field cabbages have been made by cultivation. Common cabbages have white leaves inside the heads, but there is a kind called red cabbage, used mostly for pickling, which has deep red or purplish leaves. The cauliflower, broccoli, kale, and savoy belong to the same family with the cabbage.

The cabbage is not worth much for food, as more than nine-tenths of it is water. It is better to eat it raw than boiled. Raw cabbage eaten with vinegar digests in about two hours, while boiled cabbage takes four and a half hours.

In the north of France and in the islands of the English Channel grows a kind of cabbage called the tree cabbage, because it branches like a tree. It is often twice as tall as a man, and sometimes even taller than that. It does not head like the common cabbage, and is raised chiefly for cattle, for which reason it is called by some the cow cabbage. Its stem, which grows very straight and hard, is made into canes, and is used for bean poles, and even for cross pieces for thatched roofs. Birds sometimes build their nests in the tops of these cabbages.

The word cabbage is made from the old English *cabes*, old French *cabus*, from the Latin *caput*, head.

CABLE, a large rope or chain, used chiefly for anchoring ships. ROPE cables are not much used now for ships, as iron cables take up less room and are not so stiff. Iron chain cables are not exactly like common chains, for each link has a bar called a stay-piece or stay-pin across it, to strengthen it. The links are made out of rod iron of the right size, cut into pieces and welded together—that is, hammered together when white hot, at the ends, the stay-piece, which is of cast iron, being first put in place. The largest chain cable ever made was for the Great Eastern. The links are about as thick as a man's wrist ($2\frac{7}{8}$ inches). Cables vary in length from 100 to 140 fathoms of six feet each, the fathom having originally been the space to which a man could extend his arms. As a nautical measure, a cable's length is 120 fathoms (240 yards or 720 feet) or 100 fathoms (600 feet), nearly a tenth of a nautical MILE.

Link of Chain Cable.

The word cable is from the French *cable*, which is from the new Latin *caplum*, a rope, from *capere* to take, to hold.

CACAO. See CHOCOLATE.

CACTUS, a kind of plant with thick, fleshy stems, covered with spines or prickles, but no leaves. Cactuses grow in many different shapes: some are round like a melon, some tall like a column, some spread out in branches like a tree, and some have many thick, leaf-shaped joints. Some creep on the ground like vines, and some grow five or six times as high as a man. They bear very beautiful flowers, from the purest white through the different shades of yellow to scarlet and deep purple. Among the cactuses the night blooming cereus is

one of the most beautiful. It bears a splendid yellow flower, which opens in the evening and closes forever before morning. The prickly pear, which is sometimes called the Indian fig, is not a fig, but a cactus. It grows wild in Mexico, and was cultivated there before the coming of the Spaniards, who carried it to Europe. The Moors, who called it the fig of the Christians, took it to Africa when they were driven out of Spain. The plant is now grown in the countries around the Mediterranean, where it is used for hedges, and is liked also for its fruit, which contains much sugar. Still another kind of cactus is the nopal, on which the COCHINEAL insect feeds. The cactuses grow wild only in America.

The word cactus is Latin, and is from the Greek *kaktos* a prickly plant.

CADMIUM, a metal, one of the ELEMENTS. It is white, somewhat like tin, and soft, may be beaten into sheets and drawn into wire, and makes a mark on paper like lead. It is often found mixed with zinc, and it is now chiefly got from zinc ores, though there is a cadmium ore called greenockite after Lord Greenock, on whose land in Scotland it was first found. Cadmium is not used as a metal, but a valuable color, called cadmium yellow, is made from it, much used by artists instead of Naples yellow. It is used also for coloring porcelain, and in calico-printing.

Cadmium was discovered in 1817 by Friedrich Stromeyer, professor of chemistry at Göttingen, who named it from cadmia, the name given by old writers to the oxide of zinc. Cadmia is from the Greek *kadmeia*, which means Cadmean (Theban ?) earth.

CALCIUM, a METAL, and one of the principal ELEMENTS. It is never found free—that is, alone by itself—but can be made by the chemist. When pure it is a bright, light-yellow metal, nearly as hard as gold, and is easily hammered into thin leaves and drawn out into wire. In dry air it does not oxidize, or rust, but in moist air it unites with OXYGEN quickly. Calcium is one of the most abundant things in the world, and forms parts of some of the commonest minerals. Quick LIME, made up of calcium and oxygen, is calcium oxide; limestone, MARBLE, CHALK, CORAL, SHELLS, etc., made up of calcium, carbon, and oxygen, are calcium carbonates; GYPSUM, made up of calcium, sulphur, and oxygen, is calcium sulphate; and bone earth, made up of calcium, phosphorus, and oxygen, is calcium phosphate,

What is called the calcium or Drummond light is made by putting a piece of lime or chalk, scraped down to a fine point, into the flame of the oxy-hydrogen BLOWPIPE. It will soon become white hot, and give out a light almost as bright as the sun. This light is much used in making signals, in lighting the fronts of theatres and other public buildings, and for night meetings. It is called the Drummond light because Lieutenant Drummond of the British navy first brought it into use.

The word calcium is from the Latin *calx*, lime.

CALENDAR. By our knowledge of the movements of the heavenly bodies we are enabled to measure time correctly, that is, to divide it into years, months, and days, and to make ALMANACS. This division of time is called the calendar, from the Latin word *calendarium* or *kalendarium*, an account or interest book, so called because interest became due on the kalends, the first day of the Roman month, named from *calare*, to call, because some think the Roman priests used to call the people together on that day to tell them of the days to be kept sacred during the month. In the article UNIVERSE it is shown that the time taken by a planet in going round its orbit makes its year, and the time

taken in turning round on its axis makes its day. Our year, then, is the time taken by the earth in moving round the sun, and our day the time in which it turns on its axis. A month is the time taken by the moon in rolling round the earth. By dividing the day into twenty-four equal parts we get our hours, which we again divide into minutes and seconds. To make a correct division of time it is important to know the exact length of the year. The old Egyptians gave the year 365 days, when it is really about 365¼ days long. This quarter of a day made in time such a difference in the length of the year that in the days of Julius Cæsar the seasons got out of place and spring came in the time of summer. With the aid of an astronomer named Sosigenes, Cæsar changed the calendar by adding a day to each fourth year, thus making in every period of four years three years of 365 days each and one year of 366 days. We call this fourth year leap year, because it leaps over a day more than a common year, but the Romans named it bissextile year, and it is generally so called in the almanacs. The calendar thus changed by Julius Cæsar, and called in honor of him the Julian calendar, was in use until about three hundred years ago. It was then seen that the addition of a day every fourth year was too much, for the earth really goes round the sun in a little less than 365¼ days, the time being very nearly 365 days, 5 hours, 48 minutes, and 49 seconds. To add one day to every fourth year is about eleven and a quarter minutes too much, and it was found out that the seasons had got ahead of the true year about ten days. So, in 1582, Pope Gregory XIII. ordered that ten days should be dropped out of the calendar, and October 5 of that year was called October 15 in all Roman Catholic countries. Protestant countries were a long time in making the change, and in Great Britain it was not done until 1752, when Parliament ordered that September 3 should be called September 14, thus dropping eleven days, because the calendar was then eleven instead of ten days behind. In old records and sometimes in books the letters O. S. or N. S. are used after dates; these mean Old Style and New Style, the first being according to the Julian calendar, and the second according to the Gregorian calendar, as the new one was named after Pope Gregory. The Russians still keep the old style, and in their books it is customary to see double dates given—that is, the date according to both calendars. Thus the date July 4, 1893, would be written in Russia

$$\frac{\text{June } 22,}{\text{July } 4,}\ 1893.$$

We get most of the names of our months from the old Romans. In their time the year began on the 1st of March instead of on the 1st of January. December was therefore their tenth, January their eleventh, and February their twelfth month, or the last month in their year. March, their first month, was called Martius from Mars, the god of war; April, Aprilis, from the Latin word *aperire*, to open, because the buds open in this month; May, Maius, from Maia, the mother of Mercury; June, Junius, from the goddess Juno; July, Quintilis (Latin *quinque*, five), because it was the fifth month, counting March as the first; August, Sextilis (Latin *sex*, six), the sixth month; September (Latin *septum*, seven), the seventh month; October (Latin *octo*, eight), the eighth month; November (Latin *novem*, nine), the ninth month; December (Latin *decem*, ten), the tenth month; January, Januarius, named from the god Janus; February, Februus, from a Latin word meaning to purify, because the feast of purification, at the close of the year, was held in that month. After the death of Julius Cæsar the name of Quintilis was changed to Julius (July)

in honor of him, and Sextilis was changed to Augustus (August) in honor of the Emperor Augustus. The others still bear the names the Romans gave them when the year began on the 1st of March, and we still say September, which means the seventh month, though it is really the ninth month of the year.

The division of the days of the month into weeks of seven days is also very ancient. When men believed that the earth was the centre of the universe, they thought that the sun, the moon, and the planets moved around it. The sun and moon, too, were reckoned among the planets, so that, with the five real planets which they knew (Mars, Mercury, Jupiter, Venus, and Saturn), they counted seven planets in all. From these seven planets the Romans named the days of the week, as is shown in the table, in which the Roman names of the days are given in Latin, with a translation into English, and our names of the days:

Solis Dies	Day of the Sun	Sunday
Lunæ Dies	Day of the Moon	Monday
Martis Dies	Day of Mars	Tuesday
Mercurii Dies	Day of Mercury	Wednesday
Jovis Dies	Day of Jupiter	Thursday
Veneris Dies	Day of Venus	Friday
Saturni Dies	Day of Saturn	Saturday

The Romans thus gave the names of their gods to the planets, and made the days of the week sacred to them. We have kept their names for Sunday, Monday, and Saturday; those of the other four were changed by our Saxon forefathers in honor of their own gods Tuesco, Wodin or Odin, and Thor, and their goddess Friga. So Tuesday is the day of Tuesco, Wednesday the day of Wodin, Thursday the day of Thor, and Friday the day of Friga.

CALICO, the name given in the United States to printed cotton cloths. In England common white cotton cloth is called calico; when printed it is called printed calico, or, more commonly, printed muslin.

Calicoes were at first printed from wooden blocks, and some are still made in this way. The pattern is engraved on large square blocks of pear, holly, or sycamore wood. The color to be used is thinly spread over a flat cushion or pad. The block, which is held by handles on the back, is laid face down on the pad so that it takes up some of the color. It is then laid down in the same way on the cotton cloth, which is spread on a flat table, and the color on the block is pressed on to the cloth so as to print the pattern. If there are more colors than one, there is one block for each color, and the blocks are used one after another, each filling up its own place in the pattern. The cloth is passed on as fast as printed, and a new part is brought on to the table for the blocks to be pressed upon.

Calico printing is now done mostly by machinery. The pattern is made on a roller, either of copper or brass, instead of on a flat block. This is done in several ways. In one way a coating of varnish is put on the roller, and all the parts of the pattern are cut through it so that the copper can be seen. The roller is then put into weak NITRIC ACID, which eats out the copper in all the places where the varnish is cut through, but does not touch any of the parts covered by the varnish. Thus all the lines of the pattern are eaten into the surface of the roller. Another way of making the patterns on the rollers is by rolling over them a hard steel roller, on which the pattern is cut in relief—that is, the figures of the pattern are raised above the surface of the roller. By this means the raised figures of the steel roller are pressed into the copper roller, and a perfect copy of them is made, only they are sunk in like those made by the acid, instead of raised as on the steel. (See BANK-NOTE.)

In a calico printing machine there are as many rollers as there are colors in the pattern, each roller having engraved upon it only that part of the pattern which is to print one color;

but all the parts are made so carefully that after each roller has rolled over the cloth all the colors printed fit together so as to make one pattern. In making some patterns as many as twenty printing rollers are used in one machine, but the usual number is from one to four. If the pattern has four colors in it, as red, green, yellow, and brown, there will be four printing rollers. The cloth, which is drawn along by the machinery, first passes under the red roller and has the red part of the pattern printed on it; it then passes under the green roller, which prints its part of the pattern near the red figures; and the cloth then goes in turn under the yellow and brown rollers, each of which prints in its part. The machines work so perfectly that one mile of calico can be printed with four colors in an hour. After it is printed the cloth goes over other rollers through a hot air chamber, which dries the colors.

The mixing of the colors is one of the most important parts of calico printing, and needs a great deal of knowledge and skill. Vegetable, mineral, and animal colors are used, as in dyeing, but they are mixed in different ways. Some are thickened with starch or gum, so that they are more like a paint than a dye; some have the mordant, or substance used to make the colors hold fast to the cloth, mixed with them; some are used with liquids which would spoil others; and some need to be steamed after they are printed. Each printing roller has a color roller which keeps turning over in a little trough filled with its own dye or color, and spreads the color evenly over its whole surface, filling up all the sunken lines of the pattern. If the cloth should now pass under the roller no pattern would appear; but it would be printed all over one color. To prevent this a sharp metal blade called the "doctor" is fixed close to each printing roller, which scrapes off all the color from its surface, leaving only that in the sunken lines of the pattern.

After the printing and drying of the cloths they have to be steamed, washed, starched, dried, marked, and packed in bales before they are ready for market.

The word calico is made from Calicut, a seaport of India, on the Malabar coast, from which calicoes were first brought.

CALOMEL. See MERCURY.

CAMBRIC, the finest and thinnest kind of linen cloth. It is soft and silky, and has a beautiful gloss. The best is made in France and Switzerland. A thin, delicate kind of cambric is called lawn.

A fine muslin, or cotton cloth, made to look like cambric, is also called by its name. Scotch cambric is also a muslin, but sometimes has a little flax mixed with the cotton.

The word cambric is made from Cambrai, France, where it was first made. Lawn is from the French *linon*, which is from the Latin *linum*, flax.

CAMEL. There are two kinds of camels, the Bactrian, found in Central Asia, which has two humps on its back, and the Arabian, found mostly in Arabia, Syria, and northern Africa, which has but one hump. The Arabian camel is sometimes wrongly called the dromedary, but the dromedary is only a variety of it, more slender and swifter than the common kind, and differs from it only in the same way that the race horse differs from the common horse. The dromedary is very fleet and will carry a rider more than a hundred miles in a day; the camel is much slower, and seldom travels faster than about two and a half miles an hour. But its pace is steady and uniform, and it goes on day after day and makes journeys of hundreds of miles with great ease; and it will carry twice as much as a mule.

The camel is ugly looking, but it is one of the most useful of animals. Without it the great deserts would

be impassable. Its wide, clumsy looking feet do not sink into the sand, and their thick soles protect them from its burning heat. Its eyes are fitted with long lashes which save them from the sun's rays, and it can close its nostrils at will when the sharp sand is driven by the wind. Its teeth are formed for chewing the wiry grass and thistles of the desert, and its stomach for digesting them. The camel can live on but little food, for its hump is a storehouse of fat, from which its body is supplied when it crosses the long deserts. The Arab always looks at his camel's hump before starting on a journey, to see if it is in good condition. When it is thin and poor, the animal is given rest and plenty of food until it grows again. The camel's stomach is also so formed that it can carry enough water to last it a week; and sometimes when the water of a caravan gives out, some of the camels are killed to get this supply. An Arab seldom kills a camel for food, but when one is killed all the people of the tribe share the feast. The flesh is eaten both roast and boiled. The camel generally has one young one at a birth, though sometimes two. It lives thirty or forty years.

In the beginning of summer the long woolly hair of the camel becomes loose and is easily pulled away from the skin. Out of it the Arab weaves several kinds of cloth, some of which he uses for clothing, and a coarser kind as a covering for his tent. Some camels' hair is also sent from Persia to Europe, where it is made into camels'-hair pencils or brushes for painters. Good leather is made from the skin of the camel, and in the desert its dung is very useful for fuel. Most of the cloths called "camels' hair" are made out of wool. Camels'-hair shawls are made from the wool of the CASHMERE goat.

The camel is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word camel is from the Latin *camelus*, which is from the Arabic *gamal*.

CAMPHOR, the gum of several kinds of the laurel or bay tree. Camphor is gotten chiefly in Japan, Formosa, Sumatra, and Borneo. Almost all which comes to this country is brought from Japan and Formosa; but the camphor tree has been planted in Florida, and it is thought that camphor can be successfully made there. The tree is cut up into small pieces and heated with a little water in large iron kettles, which are fitted with round covers filled with straw. The steam rises and wets the straw, and when it cools the camphor is left in the straw in small grains. The camphor of commerce is very impure and has to be refined before it is fit for use. The smell is disliked by insects, and the gum is much used, therefore, for preserving clothes and natural history specimens. The liquid called spirits of camphor is made by putting gum camphor into alcohol. Camphor is used also as a medicine and in making CELLULOID and smokeless GUNPOWDER.

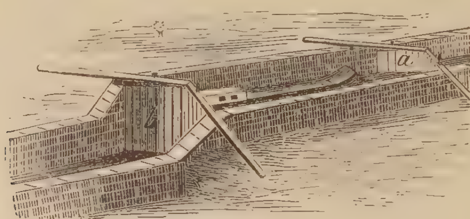
Sumatra and Borneo camphor, sometimes called hard camphor, is bought by the Chinese, who believe it to be better than other kinds, and pay very large prices for it. It comes from a tree which grows twice as high as a city house, and is as thick as the height of a tall man. The tree is cut down and split up, and the camphor is found in hard pieces in hollow places in the wood. Camphor wood trunks are supposed to be made of this tree. Camphor was not known to the Greeks and Romans. It was first brought into Europe by the Arabs.

The word camphor is from the New Latin *camphora*, Arabic *kafur*, Malay *kapur*.

CANAL, a water channel made by art. In ancient times canals were

used mostly for supplying water to the fields in countries where rain was scarce, but some were made for boats. They were generally on a level, or with a slight fall so that the water would run easily through them. They could be used, therefore, only in level countries; but in the fifteenth century, when canal locks were first made, it was found out how canals could be made of use in countries where the surface was uneven.

Canals are now usually built in several parts called levels, each level having its water higher or lower than the one next to it. In hilly districts these levels are so many and so near to each other that they look like a flight of steps. Every two levels are separated by a lock. A lock is a chamber or box, usually made of stonework, as in the picture, but sometimes of wood, and large enough to hold a canal boat. It has a gate at each end, one, *a*, opening into the upper level, and the other, *b*, into the lower level of the canal. These gates are in two parts, and open in the middle against the current or flow of the water. When a boat is going up the canal, it passes into the chamber of the lock through the lower gate, *b*, which is then closed. Water is now let into the chamber through openings in the upper gate, *a*, until the water in it is on a level with that in the upper level. The upper gate is then opened, and the boat, which has risen with the water in the lock, passes out into the upper



Canal Lock.

level. If another boat is now to pass down, it goes into the lock, the upper gate is closed, and the water is let out through holes in the lower gate until the water in the lock is lowered to the level below, when the lower gate is opened, and the boat passes out. On some canals boats are carried from one level to another on railways instead of through locks; and on others they are raised and lowered by powerful machinery.

Canals are often carried over rivers whose waters are at a lower level, or across valleys or other natural low places, on great bridges called AQUEDUCTS. The most remarkable canal aqueducts in the United States are those which carry the Erie Canal over the Genesee and Seneca rivers, and that which carries the Chesapeake and Ohio Canal over the Potomac River.

In China canal boats are usually dragged by men by means of long ropes; in Europe and the United States, by horses and mules. Steam is now used successfully on many of the larger canals, particularly in Europe and on the Suez Canal. (See C. P. P., SUEZ.)

One of the important canals of Europe is the North Holland Canal, from Amsterdam to the Helder, 50 miles long, finished in 1825. A new canal, lately built, shortens the distance from Amsterdam to the North Sea to 15 miles. The ship canal to connect the North Sea with the Baltic, from Holtenau on the Bay of Kiel to the River Elbe, built in 1887–93, is 61 miles long.

It will save 2½ days in going from Kiel to Hamburg. The Canal of Languedoc, built in 1681, connecting the Atlantic and the Mediterranean, is 148 miles long, and has more than 100 locks. The Caledonian Canal in Scotland, a series of inland lochs connected by artificial canals, connects the North Sea with the Atlantic, and saves vessels from going round by the Hebrides. There are more than 4500 miles of canals in Great Britain. The Manchester ship canal, connecting that city with the sea, 35 miles long, begun in 1887, is one of the most important. The United States have about 4200 miles of canals, 1300 of which are in New York and nearly 1000 in Pennsylvania. The Erie Canal, connecting Lake Erie with the Hudson River, built in 1825 and enlarged in 1862, is 363 miles long. The Delaware and Hudson, built in 1829, connecting New York with the Pennsylvania coal region, is 108 miles long; the Chesapeake and Ohio, finished in 1850, 185 miles; the Schuylkill Coal and Navigation Co.'s canal, built in 1825, 108 miles; the James and Kanawha Rivers Navigation, 196 miles; the Morris Canal, New Jersey, 101 miles; and the Wabash and Erie, in Indiana, 374 miles long. Canada has many canals, of which those helping the navigation of the St. Lawrence are the most important. By means of these vessels can go directly from Chicago to London, Liverpool, or other foreign ports. In 1880 M. de Lesseps, who built the Suez Canal, began to cut one across the isthmus of Panama, to connect the Atlantic with the Pacific Ocean; but, after spending a vast sum of money, the work was given up in 1888. In 1889 an American company began making a canal across Nicaragua, via the St. John's River, from Greytown on the Atlantic to Brito on the Pacific. It is expected to be finished in 1894. Another important canal, finished in 1893, is that through the Isthmus of Corinth in Greece, which saves the long voyage around the Morea (C. P. P., PELOPONNESUS. Among the longest canals in the world are the Grand Canal of China, which is 800 miles, and the canal improving the navigation of the Ganges River, India, which is 522 miles long.

The word canal is from the Latin *canalis*, a channel, trench, or pipe.

CANARY BIRD. This bird got its name from the Canary Islands, from which the first were carried to Europe; but some say it belongs in Africa, and that the first ones in the Canary Islands were tame ones which escaped from a ship. But there are now plenty of wild ones in Madeira and the Canary and Cape Verde islands. They are smaller than our tame ones and of duller plumage, being usually of a dusky gray or greenish yellow. When these birds were carried to Europe they became mixed with other birds, and there are now about fifty different kinds of canaries. Some of these are different in form from the common canary. The "Manchester coppy," named from Manchester, England, has a flat head; the "Norwich buff-crested," named from Norwich, has a topknot; and the "Belgian" is so slender that it can almost go through a finger ring.

The canary lays four to six pale-blue eggs and hatches five and sometimes six times in a season. The hen usually begins to lay in April. She sits thirteen days, during which her mate waits on her with great care and attention. The wild canary builds its nest in thick shrubs and trees, with moss, feathers, and hair. Soft straws, threads, hairs, etc., should be given to the tame canary and she will build her nest in her cage. She knows how to do this better than you can tell her. A lady once thought she would save her bird the trouble of building a nest and made what she thought was a very nice one and put it into the

cage; but the bird did not like her work at all, and tore the nest to pieces with its beak. It then built it over again to suit itself.

The hen canary will sometimes eat her own eggs. The best way to prevent this is to put her food in the cage over night, for after laying her egg in the morning she usually looks for her breakfast, and if she does not find it she may break all the eggs in her nest. If she does this when she has food enough before her she is not worth much. When the little ones are hatched the best food for them is hard-boiled egg mixed with a little wheat bread. Cut the egg up fine and add to it part of a roll which has been soaked in water a few minutes and then squeezed dry. A tablespoonful of this food will be enough, and great care must be taken to have it fresh, for if it is the least sour it may kill the young birds. The little ones are always fed by the male bird. In about two weeks they will be able to feed themselves, and when they are a month old they may be put into a cage by themselves. Up to this time they should be fed on egg and bread only, and this soft food should be kept mixed with the common food of old birds for four or five weeks longer, when the young ones may be treated like grown-up birds.

Canaries should have plenty of light and fresh air, and should be kept in rooms of an even heat: if they are too cool they are apt to become sick, and if too warm they will shed their feathers too soon. The cage should be kept very clean, and a dish of fresh water should be put into it every day for the birds to wash in. It is well to scatter some dry sand over the bottom of the cage. The favorite food of canaries is canary seed, or the seed of canary grass, which first grew in the Canary Islands, but is now raised in the south of Europe. With it a little rape, hemp, millet, linseed, and poppy seed may sometimes be mixed for a change. In warm weather give them plenty of chickweed, and now and then a leaf of watercress or lettuce. A little lettuce and a slice of sweet apple may be given also sometimes in winter, but not too often. When a bird is breeding or moping the yolk of a hard-boiled egg may be given, but as a general thing plain food is the best. Never offer canaries sweet cake or rich food; most of their diseases are caused by overfeeding.

Be careful about letting them out of the cage, and especially in rooms where there is a fire, as they are apt to fly toward a bright light. It is a cruelty to let a canary bird escape into the open air, as it does not know how to look for food and will soon die of hunger. But some have been taught to go out and come back again to their cage. An English gentleman had a canary which was never kept in a cage, but went wherever it pleased. In summer it would fly out of doors, and would always go down to the gate to meet its master, perching on his finger or nestling in his hair. It got lost, however, on a very foggy day, and was never seen again. A canary bird in France became a great friend of a large dog and took much delight in playing with it. Sometimes the dog would open his mouth wide, and the little bird would hop in there and sit without any fear. Cats are enemies of birds, and many a poor canary has been killed and eaten by them; but there was once in London a cat and her kittens who became so much attached to a canary that they would let it eat out of the same dish with them without harming it.

The canary sometimes lives twelve to fifteen years. It can be taught with care and patience to do a good many amusing tricks. The Germans teach canaries to sing tunes and the songs of other birds, but it is very slow and tedious work.

The canary belongs to the order *insessores*, or perching BIRDS, and

to the finch family, which includes also the larks, sparrows, and linnets.

CANDLE. The ancients had no candles like ours. The Greeks and Romans sometimes used strips of a kind of paper called papyrus, soaked in pitch and covered with wax, but they depended for light mostly on oil lamps. In England in early times splinters of wood and the pith of rushes dipped in tallow were the only candles.

Candles are now made of tallow, wax, spermaceti, stearine, paraffine, and some kinds of oils. Tallow candles are usually made of a mixture of mutton and beef tallow, and wax candles of beeswax. Spermaceti is obtained from the head of the sperm WHALE. Stearine candles are made from tallow so purified of its oleine or oily matter that only the solid white part is left. When pure, stearine looks like white wax, and has no taste nor smell. Paraffine is a substance something like spermaceti, made from peat, coal tar, bituminous coal, and other things. Candles made of it are almost as good as those of wax and spermaceti. Palm and cocoanut oils are also good for making candles.

Candles are usually made in one of three ways: by dipping, moulding, or rolling. Dipped candles are made of the coarsest kinds of tallow. Wicks of cotton yarn, hung side by side on a stick, are dipped many times into melted tallow and allowed to harden each time until the candles are large enough. Mould candles are made by pouring melted tallow into tin, pewter, or glass moulds, each of which is shaped like a candle and has a wick stretched through the middle. As the moulds are larger at the bottom than at the top, the candles are easily drawn out when cold. Stearine, paraffine, and palm oil candles are also made in moulds. Wax candles are not made in moulds, because wax shrinks much in cooling, and is also apt to stick to the mould. The wicks are dipped into melted wax, and then rolled into shape while warm on a hard wood or stone table by means of a boxwood roller, which is wetted with water to keep the wax from sticking to it. Wax candles are sometimes shaped by drawing them through holes in a machine, just as wire is drawn. Both wax and spermaceti candles are often made of different colors.

In China grows a tree called the tallow tree, from which the Chinese make candles. The tallow comes from the seeds, which are pounded and boiled in water, when the fat rises on the top. This is skimmed off, and when cold is as white as snow and almost as soft. When the Chinese make candles out of it, they mix wax enough with it to harden it. They are said to give a bright, clear light. The tallow tree has been planted in Georgia, South Carolina, and Florida, and many are now growing in those States, but no use is made of them. In the South Sea Islands, and in Japan, Madagascar, Java, and other East Indian islands grows a tree called the candle-nut, the nuts of which are used, strung on strips of bamboo, to burn as candles. They are full of oil, which is easily pressed out, and it is sent to England, where it is used for lamp oil and made into candles.

But the most curious kind of candle is that made out of a fish by the Indians on the Pacific coast of British Columbia. This little fish, called the enlachon, or candle-fish, is about a foot long, and looks much like a SMELT. It is one of the fattest of all fishes, and when dried will burn with a bright flame till burned up. The Indians sometimes burn it alone, lighting it at the tail, and sometimes run a wick of woody threads through it. They also dry and smoke this fish for winter food, and use the oil for butter.

The word candle is from the Anglo-Saxon *candel*, Latin *candela*, a candle, from *candere*, to shine.

CANDY. To make candy one must know all about boiling sugar, as some kinds do not need so much boiling as others. If some crushed sugar be heated, with a little water, the lumps will first soften and break up and then melt into a clear liquid. If this be boiled, a good deal of the water will pass off as steam and the liquid will become thicker. By setting this aside and letting it cool slowly, the sugar will form in large, clear crystals on the sides and bottom of the kettle. This is what is commonly called rock-candy. If, instead of allowing it to cool, the liquid be boiled still more, most of the water will pass off in steam, and the sugar will form in grains around the kettle; but if it be made still hotter the sugar grains will melt, and the whole will become a thick, clear, paste-like syrup. If a spoon be dipped into this and drawn out, a long thread of melted sugar will follow it; and if a little of it be dropped into cold water it will become hard and brittle. Most candies are made from sugar in this state. If the syrup be heated still more it will froth and become dark brown, and turn into what is called caramel.

There are eight or nine different degrees or stages in boiling sugar, for each of which the confectioners have a name. Besides sugar, there are many other things used in making candy, particularly for flavoring, such as the syrups and juices of fruits, berries, nuts, and seeds. Several kinds of liqueurs or cordials, acids, and gums are also used, and many different coloring extracts. Some of the colors used by confectioners are poisonous, and children have been made very sick from eating candies colored with them. The most dangerous ones are yellow and orange, which are often made with chromate of LEAD. Bright red candy is sometimes colored with vermilion, made from MERCURY, and green candy with verditer and Brunswick green, made from COPPER, all of which are poisonous. In buying candy it is best to pick out those kinds which are not brightly colored. But even white candies, especially cheap kinds, are not always safe, for they are usually mixed with chalk, plaster of paris (see GYPSUM), pipe CLAY, and starch. Although these things are not really poisonous, they are not healthful to eat, and often lead to illness. Instead of cane sugar confectioners make large use of grape SUGAR made from starch, and many use a thick syrup made from the starch of Indian corn. The making of candy takes a great deal of care and skill, and only the best workmen can make all the kinds. The French workmen are the most skilful.

We can tell here only about a few of the common sorts of candy. **Sugar Plums,** which are called comfits in England, are made of almonds or some other nut, or of some small seeds like caraway seeds, coated with sugar. The almonds or seeds are thrown into a copper pan with a paste of sugar, syrup, and starch. The pan is hung over a fire and is kept moving all the time so that the almonds are kept rolling over each other. They thus become coated with the paste, which thickens as it dries, and the pan is kept in motion until they are of the right size. Sugar plums can be made of only one color at a time.

Gum Drops are made of GUM Arabic and sugar, but sometimes Barbary gum and gum Senegal are used. The mixture, which is made about as thick as honey, is flavored and colored to suit the taste. When it is ready a shallow box is filled with fine starch, the top of the starch is smoothed over, and little hollow places of the size and shape of the gum drops are made in it. The mixture is then poured into these little moulds, just enough being put into each to make one gum drop. The mould is then set away in a warm place to dry for several days,

until the drops are hard enough to handle.

Bonbons with liqueurs in them are made in a similar way. A thick syrup of sugar and water has some kind of liquor added to it, and it is then poured into little moulds, of the right size and shape, made in fine starch. The syrup draws up into a round form, just as a drop of water would in dry flour; a little starch is sifted over the top, and the whole is set aside to dry. The sugar on the outside soon crystallizes and forms a crust around the bonbon, and as it dries the syrup on the inside adds more and more of its sugar to the crust, and thus becomes thin.

Lozenges are made of sugar flavored with peppermint or other essences, worked up into a dough, and rolled out flat and thin. It is then stamped with various mottoes and cut out by punches into the shapes wanted.

The word candy is from the Arabic *qandi*, made of sugar, Hindu *quand*, sugar.

CANNON. The parts of a cannon are shown in the picture, Fig. 1, which is that of a heavy gun of the common kind formerly used for seacoast defence. In this, A is the breech, B the first re-enforce, C the second re-enforce, D the chase, and E the muzzle; F F are the trunnions, and H is the bore. The diameter of the bore is called the calibre. Such a cannon is generally fixed upon a heavy frame, called a carriage, which moves on small iron wheels, and which is so made that the muzzle of the gun can be easily raised or lowered. Cannon of this shape are not made now, but the same parts in any large gun are called by the same names.

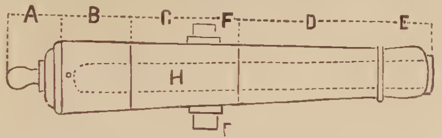


Fig. 1.—Parts of a Cannon.

Early Cannon. Cannon did not come into use until several centuries after the invention of GUNPOWDER. The first cannon are supposed to have been made about the twelfth century by the Arabs, who learned the nature of gunpowder from the Chinese. The Mohammedans used cannon in India in A. D. 1200, and Genghis Khan had artillery at the seige of Tsaichew, China, in 1234. The Moors, who conquered Spain, are said to have used artillery against Cordova in 1280. Soon after this, in the first half of the fourteenth century, cannon came into use throughout western Europe. The city of Ghent had stone-throwing guns in 1313, and the English used them at Crécy in 1346.

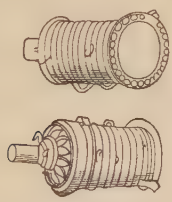


Fig. 2.—Austrian Cannon.

The first cannon were shaped somewhat like a druggist's mortar, or like a can (German *kanne* or *canne*), and from this comes our word cannon. An early one, made in Austria about the beginning of the fourteenth century, is shown in Fig. 2, where a front and a rear view of it are given. It is made of iron bars held together by hoops of iron, and is 3 feet 6 inches wide by 7 feet 10 inches long.

The first breech-loading cannons, called bombardes, were made in the same way—of iron bars held together by rings. They were wider at the

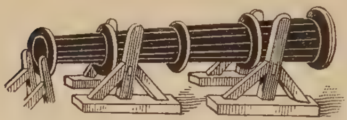


Fig. 3.—Bombard.

mouth than at the breech, as seen in Fig. 3, which shows one used by the English at the battle of Crécy. After loading, the breech was plugged up with wedges of metal or wood, driven in with a mallet.

The next kind of cannon made, called the veuglaire (German *Vogler*, fowler), also a breech-loader, had a separate chamber for holding the charge, which screwed into the end of the barrel. In Fig. 4 is shown

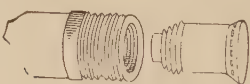


Fig. 4.—Veuglaire.

the breech parts of one of these guns, made of forged iron at Ghent between 1404 and 1419. But the early cannon founders did not know how to make breech-loaders strong enough, so they soon after began to make cannon that loaded at the muzzle; and this kind was most in use up to the present century, when breech-loaders came into fashion again. Two singular breech-loaders carried to Mexico by Cortez are now preserved at the Naval Academy, Annapolis.

Cannon have had many different names—such as culverins, demi-culverins, serpentines, basilics, spirales, falcons, and falconnettes, some of which differed in shape from others, though sometimes the same gun is called by a different name in different countries. Culverins were long guns, often four times as long as a man, the early artillerists believ-

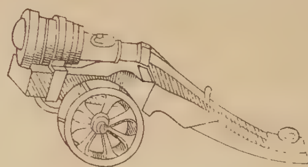


Fig. 5.—Gun used at Morat.

ing that the longer the gun was the farther it would shoot. A culverin is shown in Fig. 6.

Early cannon were sometimes made of wooden as well as of iron bars, wound round with rope and covered with leather, and sometimes of a brass tube similarly wound and covered. They were next made of wrought or hammered iron, and later of different kinds of cast metals. The first balls were round stones, but they soon gave place to lead and to iron balls. Trunnions were first cast on guns about the beginning of the fifteenth century, and soon afterward cannon were mounted on

Fig. 6.—Culverin.

wheels. In Fig. 5 is shown a gun used at the battle of Morat (1476), with a wheeled carriage shaped much like those now in use.

Modern Cannon. In more modern times many different kinds of guns have come into use, such as the carronade, howitzer, shell gun, mortar, etc. Carronades were named after the Carron iron works in Scotland, where these were first made. They were short iron guns for shooting a

large ball, and were once much used in close naval battles to smash in the sides of ships; whence sailors called them smashers. Howitzers are light, short guns, used in battles on land to throw shells into the enemy's ranks at short distances. Mortars are so called because they are shaped like an apothecary's mortar. They are very short, with a large bore, and are used to throw bombs or shells into the air so that they will fall into fortified places. They are usually mounted on an iron carriage, like that shown in Fig. 7. Shell guns are long cannon used for shooting

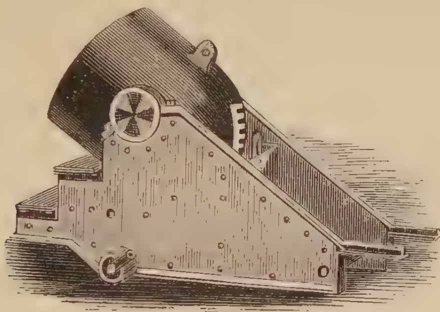


Fig. 7.—Mortar.

shells (see SHOT and SHELL) straight at an object. They are like howitzers in shape, but much longer.

Cannon are now made of cast iron, wrought iron, cast steel, and bronze or brass. BRONZE for gun metal is made of nine parts of copper and one part of tin. Guns are usually cast solid and bored out afterward, but some are cast hollow. Wrought IRON guns are made by welding or hammering together rings or strips of red-hot iron around a mandrel or bar of metal, which is

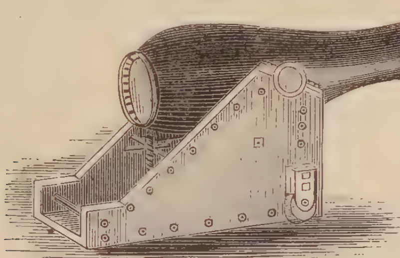


Fig. 8.—Rodman Gun.

afterward bored out. Some guns too are made of steel barrels wound round with wire, much as the old guns were wound with rope, and then covered with iron rings put on red hot, which shrink tight when cold.

Up to the time of our civil war, before ironclad ships came into use, cannon were made mostly with smooth bores. The Columbiad, a heavy gun invented by Colonel Bomford, was used in the war of 1812. Lieutenant Rodman found out how to cast these hollow, and made very large guns that were named after him. Other guns, named also after

their inventors, the Dahlgren and the Parrott guns, were also smooth-bore guns. The Rodman gun (Fig. 8), which could be made large enough to carry a ball 20 inches in diameter, would smash in the side of an ordinary ship, but would not go through thick steel armor; so, when ships began to be heavily plated, rifled-guns which could penetrate such armor came into use. These were first largely made in Europe by Armstrong and Whitworth, in England, by Canet in France, and by Krupp in Germany, all of whom made great improvements in cannon. We began first by changing some of our large smooth-bore guns into rifled guns, but these were poor compared with the rifled guns made in Europe, and in 1885 we began to make real rifled guns, which are as good as any in the world. Rifled guns are made of an inner steel tube with several jackets or bands, one over the other, as shown in Fig. 9. They are very long, some being 35 times as long as their calibre, and the largest ones weigh more than a hundred tons.

The manufacture of one of these monster guns is a very difficult matter. The great piece of steel from which the barrel is to be made is, when brought from the forge, a little larger than is needed. It is first rough-turned in a lathe, and then rough-bored. This is done by a machine which works night and day, cutting out four or five inches an hour. After rough-boring, it is heated and plunged into a bath of oil to toughen it, and is next fine-bored, that is—smoothed inside, and then turned smooth on the outside. The barrel is then set up on end to have its jackets put on. Each jacket is made a little smaller than the one it is to go over; but when heated nearly red-hot it expands enough to slip on easily, and when it cools it fits so tight as to become almost a part of the under one. In the largest guns there are generally five or more jackets, the lower one of which covers the barrel entirely to the muzzle. The other jackets are shorter, being intended to strengthen the breech, where the principal strain comes in firing. It takes more than a year to build up a gun thus, and it then has to be smoothed and rifled. The rifling is done by a machine which cuts one groove at a time, turning round all the while so as to give it the proper twist. Sometimes there are as many as eighty grooves in the rifling of a large gun, and it takes at least a month to finish it.

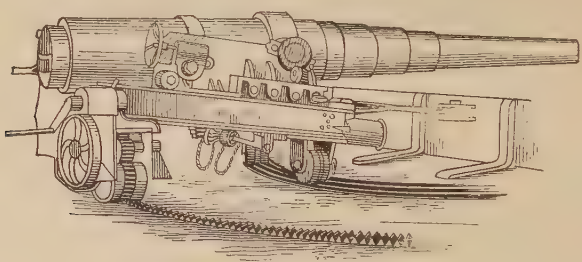


Fig. 9.—Rifled Gun.

Steel guns are made in this country from 4 inches up to 12 inches calibre. The 12-inch gun takes 425 pounds of powder and carries a projectile weighing 850 pounds. Larger guns than these have been made

in Europe. Krupp made four for the Italian government of 16 inches calibre, each gun weighing 118 tons. These great guns will pierce a plate of steel more than two feet thick at a distance of two miles, so it is doubtful if any ship could stand a shot from one of them (see SHOT AND SHELL).

Dynamite Gun. This gun, meant to throw shells loaded with dynamite, was invented by Mr. M. D. Mefford, of Ohio, but was made of practical use by Capt. E. L. G. Zalinski of the United States Army, and Capt. Rapieff of the Russian Army. Dynamite and explosive gelatine will explode by concussion, so that it is very dangerous to fire a shell loaded with either of them from an ordinary cannon with gunpowder. In the dynamite gun the shells are fired by means of compressed air, which does not jar the dynamite as the explosion of gunpowder does. The shell, which is really a TORPEDO, is so made that it will explode on striking an object like a ship, or on entering the water near it, or after it has reached a certain depth. It is thus pretty likely to blow up any vessel near which it falls. Dynamite guns are made from 4 inches up to 15 inches calibre. A 15-inch gun is 55 feet long and will carry a shell loaded with 500 to 600 pounds of dynamite more than a mile; and a smaller shell more than three miles.

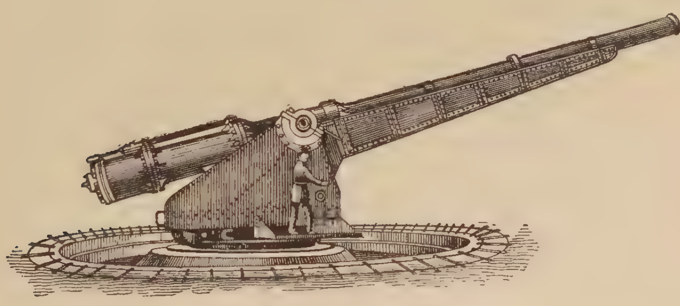


Fig. 10.—Dynamite Gun.

Machine Guns. These are cannon in which everything connected with the loading and firing is done by machinery. They use metallic cartridges, generally have several barrels, worked by turning a crank at the side, and fire one shot after another, like a revolver pistol. They can fire much more rapidly than guns worked by hand, and are very serviceable in close fights, in repelling storming parties from forts, boarders from ships, and charges of cavalry or infantry in battles.

The Mitrailleur, invented in Belgium about 1866, had 25 to 37 barrels, put together in a bundle. It fired all its shots at once in a volley; so it is not properly what is now called a machine gun. It was used by the French in the war with Germany in 1870-71, but has been superseded by other guns.

The Gatling gun, invented by R. T. Gatling, an American, in 1861, is the earliest of real machine guns. It has ten barrels put together in a bundle, all of which revolve when the crank is turned. As many as 1000 shots can be fired in a minute, when the crank is turned by hand; and 1500 shots when it is worked by an electric motor.

The Hotchkiss revolving cannon, invented by B. B. Hotchkiss, an American, in 1875, has its barrels

arranged also in a bundle, and is worked like the Gatling with a crank. It will fire 60 to 80 shots a minute, and both solid shot and shells may be used in it.

The Nordenfeldt gun, invented by Thorsten Nordenfeldt, a Swede, in 1879, has its barrels arranged horizontally in a row, and is worked by a lever on the side, working backward and forward, instead of by a crank. It will fire 200 to 600 shots a minute.

The Maxim machine gun, invented by Hiram Maxim, an American, is automatic—that is, it works itself. It has a single barrel so aranged that it will recoil (slide back) slightly when fired. This recoil acts on the machinery so as to load and fire the next shot, and so on, shot after shot, in succession. The cartridges are arranged on a belt about seven feet long, each belt holding 333 cartridges. The first cartridge is put into the barrel by hand, but after it has been fired the gun feeds itself and continues firing until all the cartridges on the belt are gone. Another belt may be pieced on the first before it is used up, and so the gun will keep firing until it gets too hot for use. When at full speed 600 shots a minute may be fired, but it may be adjusted to fire as slowly as the gunner wishes.

The Lowell gun, made at Lowell, Massachusetts, and the Gardner gun, each of which will fire 350 shots a minute, are other kinds of American machine guns.

Rapid-fire Guns. These are light single barrelled cannon using metallic cartridges and loaded wholly or in part by hand, though the cartridge shell is thrown out by machinery as in the machine gun.

The Hotchkiss gun, invented by B. B. Hotchkiss, can be fired 10 to 20 times a minute, and is sighted and fired by one man. The larger sizes are mounted on carriages, but the smaller ones used on naval vessels are mounted on a pivot and have a stock which the gunner holds against his left shoulder; he pulls the trigger with his right hand when he gets the gun aimed right. French men-of-war carry 20 to 30 of these guns, and have many sockets on each side of the ship so that the guns may be quickly moved from one part to another. The Nordenfeldt rapid-fire gun, the chief rival of the Hotchkiss in Europe, will fire 12 to 30 shots a minute. The Driggs-Schroeder rapid-fire gun, the invention of two officers of the United States Navy, has been tried and approved. Other rapid-fire guns are the Armstrong, the Krupp, the Canet, the Albini, the Gruson, and the Maxim.

Field Guns. Cannon for use by armies in the field are mounted on gun carriages drawn by horses. The common form of the carriage is seen in Fig. 11, which shows an old style muzzle-loading field gun. The part marked A is the stock, B the cheek, C the screw by which the end of the gun is raised or lowered, and D the trail. A gun with the stock

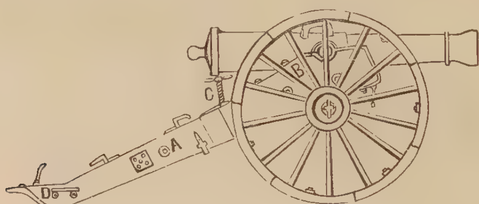


Fig. 11.—Field Gun and Carriage.

on the ground, ready to be fired, as in the picture, is said to be unlimbered. The limber is the fore part of a gun carriage, the part to which the horses are hitched. It is made up of two wheels and an axle, on which is an iron box for carrying powder and other things for loading the gun. The cannoneers ride on seats on the top of this box. When the cannon is to be moved, the stock is raised up and the trail (D) is fastened to the limber.

Many kinds of improved field guns are now used, most of which load at the breech. Gun carriages too are made of steel, and are much lighter and stronger than the old kinds. Some machine guns made for use in the field have wheels made of steel plates that can be turned so as to come together in front and form a kind of shield to protect the gunners from rifle-balls.

CANOE. See ROW-BOAT.

CANVAS, a coarse kind of cloth, usually made of flax or hemp. Artists' canvas is the material on which most oil paintings are made. Before using it is usually primed, or covered with a preparation of chalk and size or of white lead, which when dry is ground until its surface is smooth. It is also generally stretched on wooden frames of the size of the picture. A light kind of canvas, made with open threads, is much used by ladies for embroidering. Canvas for the sails of ships is commonly called sail cloth. It is made of flax, of cotton, or of cotton and flax mixed, and is carefully and strongly woven. It is usually very narrow, so that many widths are sewn together in making a sail. A kind of coarse, light canvas, used for small sails, is called duck (German *tuch*, cloth).

Other kinds of canvas are used for tents, awnings, etc.

The word canvas is from the Latin *cannabis*, hemp.

CAPER, the pickled flower bud of the caper shrub. The caper is a low trailing shrub common in the south of Europe. It is largely cultivated in France, Italy, and Sicily. The buds are picked every morning in the season, which lasts from May to November, and put into vinegar and salt. They are used chiefly in making sauces.

The word caper is from the Latin *capparis*, Greek *kapparis*, Arabic *kabbar*, the caper plant.

CAPSTAN, a machine on a ship, used to heave the anchor, to hoist heavy weights, etc. It consists of a barrel made of heavy timber, around which a rope or chain coils, and which turns round on a pivot working in the deck under it; the drum-head, a round flat head of timber, with holes round its edge for the

Capstan.

capstan bars to fit in; the pawls, or RACHETS to keep the capstan from turning backward; and the bars, or levers to work the capstan with.

The sailors put the bars into the square holes of the drum-head and turn it around, thus winding up the rope or chain around the barrel and raising the anchor or other weight.

The word capstan is from the French *cabestan*, a capstan.

CARAT, a weight used for diamonds and other precious stones. It is equal to about $3\frac{1}{8}$ troy grains, $151\frac{3}{4}$ of them being equal to a troy ounce. It is divided by jewellers into four grains, called diamond-grains. As the diamond-grain is less than the troy grain the jeweller has to keep a separate set of weights for diamonds.

The **Gold Carat** is a measure, not a weight. It is used to express the

fineness of gold used in jewelry. Pure gold being taken as 24 carats fine, gold mixed with an alloy is said to be of as many carats as there are parts of pure gold in it; thus, gold 18 carats fine has 18 parts of pure gold and 6 parts of alloy. Gold of this quality is used for making watch-cases and for mounting jewelry; gold of 14 carats for watch chains, and gold of 22 carats for wedding rings.

The word carat is from the Arabic *qirat*, carat, a weight.

CARAWAY, the seed of a small plant which grows wild in Europe. It is much cultivated in Germany and England. The roots are somewhat like the parsnip, and are eaten in the north of Europe. The seeds are used as a medicine, and to flavor liquors, confectionery, cakes, bread, etc. The liqueur called *Kümmel*, much used in Germany and Russia, is made by distilling caraway seeds in spirit. Oil of caraway is made by distilling (see ALCOHOL) the seeds with water.

The word caraway is from the Latin *careum*, some think from Caria, in Asia Minor.

CARBON, one of the ELEMENTS and one of the most common and most important substances in nature. It forms a large part of all vegetables and animals, and of many minerals, such as coal, graphite, asphaltum, limestone, chalk, and marble. The DIAMOND is pure carbon in the form of crystal. Anthracite COAL and BLACK LEAD or graphite are nearly pure forms of carbon, but uncrystallized. CHARCOAL, COKE, and LAMPBLACK also are carbon, but they are more or less impure.

Carbon takes many forms when mixed with other substances. With OXYGEN it forms CARBONIC ACID, without which plants could not live (see AIR), Carbonic acid, united with metals, earths, and ALKALIES, produces what are called the carbonates, which are so useful in the arts. Chalk, marble, and limestone, for instance, are carbonates of CALCIUM, made by uniting different parts of carbonic acid with the metal calcium. Common GAS, which is burned for lights, is formed of carbon and HYDROGEN. Wood, gum, starch, sugar, oil, gelatine, and many other things are made up of carbon, united with hydrogen and oxygen.

The word carbon is from the Latin *carbo*, coal.

CARBONIC ACID GAS, a compound substance formed by the union of CARBON with OXYGEN. There is some in the atmosphere or AIR, but only a very small quantity compared with oxygen and nitrogen, there being but about one gallon of it in every 2500 gallons of air. In places around volcanoes it is more plentiful, and it forms a large part of some minerals, such as chalk, marble, and limestone.

In its usual form carbonic acid is a colorless gas, with a slightly acid smell and taste. It is half again as heavy as air, and may be poured from one jar into another, taking the place of the air at the bottom before mixing with it. It often settles in the lower parts of mines, pits, and wells, and men and animals who go down into such places are sometimes overcome by it and die before they can receive aid. At Naples in Italy is a cave called the Grotto del Cane (Dog Cave), into which a dog is put to show visitors how the gas acts. The dog becomes insensible in a few seconds and is taken out and dashed with cold water, which restores him. As nothing can burn in this gas, it is always safer to let down a candle where it is supposed to be: if the gas is there the candle will go out; but if the candle burns brightly the air is good enough to breathe.

Carbonic acid gas is deadly because it acts like a poison when breathed into the lungs. In this it differs from NITROGEN, in which animals die not because it is poison, but because they are shut out from

oxygen. The carbonic acid gas in the air does not injure us, because there is so little of it, and because the air keeps always in motion so that the gases of which it is made are kept well shaken up together. If the air were still all the time, the carbonic acid gas, which is so much heavier than the other gases, would settle in the valleys and other low places on the earth, and men and animals could live only on the mountains. In the island of Java is a valley where carbonic acid gas rises so as to be deadly to animals, which are said to drop dead in trying to cross it. This is supposed to have given rise to the fable of the upas tree, reported to be so poisonous that no man could go near it and live.

Though carbonic acid gas is a poison when breathed into the lungs, it is harmless and even healthful when taken into the stomach. It will dissolve or melt in water, but when put under strong pressure it will dissolve much more freely than when under only the common pressure of the air. Water thus charged or filled with it has a pleasant, brisk, acid taste, and effervesces or bubbles up when the pressure is taken off, as when it flows out into the air. Mineral water, which comes out of the earth in many places, is natural carbonic acid water, and what is wrongly called SODA WATER is the same made artificially or by hand. When soda water is drawn from the fountain the pressure is taken off and the carbonic acid gas bubbles up and makes it foam. The same gas makes cider, ale, porter, and champagne fizz when their corks are drawn and they are poured out.

Carbonic acid gas will turn into a liquid if it be put under great pressure; and if the liquid be exposed to cold it will become a solid white mass which may be made into a ball like snow.

CARD. Cards, whether visiting, business, or playing cards, are first made in sheets and then cut up into the sizes wanted. The sheets, which are called cardboard, are made in two ways: common cardboard is made of pulp on the PAPER machine; but the finer kinds are composed of several sheets of paper pasted together. Most playing cards and Bristol board are thus pasted. Bristol board (named from Bristol, England, where it was first made), which is used by artists and for the finest visiting cards, is made entirely of sheets of white paper, but common cardboard and the board from which playing cards are cut have fine paper on the outside only, the inside being made of one or more sheets of cheap cartridge paper.

In making cardboard for playing cards, the first sheet, on which has been printed the design for the back of the cards, is laid down on a table and the white side of it is brushed over with paste. A sheet of cartridge paper is next laid on it, and the workman brushes this also with paste and lays on it the sheet which is to make the face of the card. This forms one sheet of cardboard. He now lays another back sheet on this face sheet, and makes another cardboard, and so on until he has a large pile, which is put into a press where all the water is squeezed out of the paste. The sheets are then separated and dried for a day in a heated room. They are now rough and warped, but they are flattened and made smooth by passing them between smooth steel rollers and afterward pressing them very hard in a press where every sheet of cardboard is placed between two sheets of smooth zinc. If they are to be enamelled, they are brushed over with a mixture of China clay or white lead and water with a little glue in it; when dry, this is rubbed over with a piece of flannel dipped in powdered soapstone, and afterward polished with a brush.

The faces of playing cards are printed from blocks, much like those

used in CALICO printing, there being one block for each color. A whole pack of cards is printed on one sheet of paper, so that each card shall be of exactly the same thickness. For the history of playing cards and the games played with them, see Young Folks Cyclopædia of Sports and Games.

The word card is from the Latin *charta*, a sheet of paper.

CARDAMOM, the seeds of a plant which grows in India. They come in a three-cornered pod, about half an inch long, and of the color of an orange seed. The seeds, which are about as large as mustard seeds, are reddish brown on the outside and white within, and have a pleasant smell and taste. They are used as a medicine and as a flavor. In India they are put into soups, catsups, and curries.

The word cardamom comes from the Latin *cardamomum*.

CARDINAL BIRD, a bird of the finch family, called also Cardinal Grosbeak, and Cardinal Red-bird. It is a bright vermilion red, darker on the back, with a red bill surrounded by a band of black, and black on the throat. It is found from the Middle States southward and west to the Rio Grande. Cardinal birds are fine singers, with rich clear notes, and are highly prized for cage birds, especially in England, where they are called Virginia nightingales. Their nests are built in holly or laurel bushes, of twigs, leaves, and grasses, and they lay four white eggs marked with reddish brown or chocolate.

The cardinal bird is so called because its color is like that of the vestments of a cardinal.

CARP, a kind of fish of the same family with the SUCKER and the GOLDFISH. The common carp is a European fish, but has been put into the Hudson and some other northern rivers of the United States. Carp weigh usually one to fifteen pounds and are very good eating. They like quiet waters, with soft muddy bottoms, and will bite at a worm, a light-colored one being better than an angle worm, but they are shy fish and do not give much sport to the angler.

The word carp is from the French *carpe*, German *karpfen*.

CARNELIAN. See AGATE.

CARPET. To understand the terms used in this article, the article CLOTH should be read first. Some of the best carpets take their names from the places where they were first made: Turkey carpets were first brought from Smyrna and Constantinople, Brussels carpets from Brussels in Belgium, and the Axminster, Kidderminster, and Wilton carpets from those towns in England. But no carpets are now woven at Axminster, and most of these styles are made in different countries; Brussels carpets are manufactured largely in England and in the United States, and Wilton carpets also are produced here and in France, where they are called *moquette*. (French *moquettes*, tufts of wool).

Turkey carpets are woven by hand, and mostly by young girls in families. They are made on a linen warp, the warp threads being unwound from a roller at the top of the loom and wound up on another roller at the bottom. The weaver twists around each thread of the warp little bits of colored yarn, each tuft being of the proper color to make the part of the pattern she is there working on. When she has gone across the row of warp threads, she passes a linen weft over the tufts by means of a shuttle, and drives it down close so that all the tufts of colored yarn are fastened securely. Other rows are laid in the same way until the carpet is done, when the tufts are all sheared down to an equal height. Turkish carpets are very rich in color and very soft to the foot. Persian and Indian carpets are made like the Turkish, and very similar in color and pattern. Many imitations

of Eastern carpets are made in Europe, especially in France and Belgium.

Axminster carpets are an imitation of the Turkish, but are handsomer, because they are much more evenly made, and worsted instead of woollen yarns (see WOOL) are used in them. They are so costly that very few of them are now woven.

Brussels carpets are made of linen and worsted, but only the worsted shows on the upper side. The under part looks like a coarse linen cloth. The worsted yarns are woven like VELVET over wires which are laid across the warp from one side to the other. These wires are afterward drawn out, leaving the worsted yarns standing in a row of loops across the carpet. The surface of all Brussels carpets is made up of these rows of little loops, of which there are sometimes more than three hundred in a yard.

Wilton or moquette carpets are made like Brussels, but they are woven over a wire with a groove on the top instead of a round one. The wire is not drawn out, as in the Brussels, but is cut out by drawing a sharp knife along the groove. This separates all the loops, and they stand up and make what is called a pile, like the threads in velvet. The pile is afterward sheared so as to make a smooth even nap.

Tapestry and velvet pile carpets are imitations of Brussels and Wilton, but are cheaper and do not wear so long. In Brussels and Wilton carpets as many yarns are used as there are colors, but in the tapestry there is but one yarn, which is printed different colors, in different parts of its length, in such a way that, in weaving, the proper color always comes in the right place in the pattern.

Kidderminster carpets are known in the United States as ingrain and three-ply. Ingrains are made of two thicknesses interwoven or ingrained together, so that they are really two carpets linked together. Three-ply carpets are made in the same way, but are made up of three instead of two webs, curiously interlaced. These carpets have the same pattern on each side, only the colors are different.

There are many other kinds of carpets, such as Venetian, printed felt, and rag carpets, but they are not much used. Jute carpets are now much made at Dundee, Scotland. Some are woven plain, and some are printed in colors.

The word carpet is from the new Latin *carpetta*, plucked wool, probably from Latin *carpere*, to pluck.

CARRIAGE. A carriage is properly any vehicle on wheels in which anything is carried, but the name is now usually given only to vehicles hung on springs, and used for pleasure. Four-wheeled vehicles used for carrying goods and heavy loads are commonly called wagons. Carts have only two wheels and generally no springs.

History of Carriages. In ancient times the only carriages were two-wheeled carts called chariots, which were used for both pleasure riding and in war, the only difference being that the war-chariots were open behind so that the warrior could easily jump in and out, while those used for pleasure or show were generally closed behind and had a seat. Chariots were much used also for racing in the ancient circuses and hippodromes. The Assyrians, Greeks, Romans, and other nations used nearly the same kind of chariot. About the time of Christ the chariot went out of use, and a kind of carriage with four wheels, fitted up with cushions and sometimes with an awning or canopy overhead, and drawn by four or six horses, came into use among the rich; but it had no springs and was a clumsy and heavy vehicle compared with the carriages of to-day. After the fall of the Roman Empire even these went out of use, and people travelled from

place to place riding on horses, mules, or asses. Three or four hundred years ago carriages began to be used again, but none but kings and nobles had them, and they were still very rudely made and without springs. In 1550 there were only three coaches in Paris. Fourteen years after this Queen Elizabeth had a carriage made for herself, like the one in the picture, in which she rode on great state occasions. The men with halberds (axes with long handles) on their shoulders are the guards, and the one behind without any halberd is a footman, so called because he went on foot beside the carriage. In these days footmen ride on the carriage, but they still keep the same name.

When the English settled in New England (1620), there were but few carriages in England, and most of them belonged to the nobles and the rich. About that time a few hackney coaches, now called hacks in the United States, were kept in London. Hacks are still used in this country, but in London four-wheeled vehicles drawn by one horse, named cabriolets, usually called cabs, and two-wheeled vehicles, called hansoms (from their inventor), in which the driver sits behind, have taken their place.

At the time of the Revolution there were in this country only a few carriages belonging to rich families. They were heavy, clumsy vehicles, drawn by four or six horses. Stage

Queen Elizabeth's Carriage. From an Old Picture.

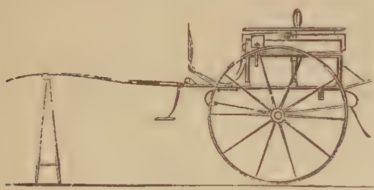
coaches were unknown and people travelled mostly on horseback; but after the beginning of this century, when the roads were made better, good coaches were run between all the larger cities, and these were much used by travellers until railroads were built. Omnibuses were first used in Paris about 1827, and in New York in 1830.

Modern Carriages. There are now so many kinds of pleasure carriages in use in the world that we cannot give even a list of their names. Some have four wheels and some but two, some are open and some have tops, and some are made to be drawn by one horse, and some by two or more. Of carriages usually drawn by one horse, the principal ones in use are the gig, chaise, sulky, and dog cart, which have but two wheels, and the buggy, phaeton, rockaway, coupé, brougham, T cart and Victoria, which have four wheels, and which are sometimes used with two horses. The principal carriages usually drawn by two horses are the coach, clarence, barouche or brett, and landau.

The gig is a light two-wheeled carriage with a single seat. The chaise is much like it, but has a calash top—that is, a top like a buggy-top, which can be let down. A sulky is a very light gig with a seat for only one person, and is used mostly for trotting-races.

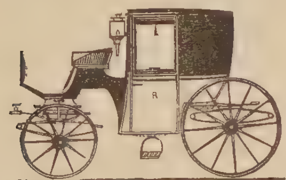
The **Dog Cart** is so named because it was once much used by

sportsmen, who carried their dogs to the hunting field in a box behind. The dog cart is sometimes driven



Dog Cart.

with one horse in the shafts and another horse ahead of it. This is called driving tandem (Latin, meaning at length). Sometimes three and even four horses are driven in this way. A French dog cart has four wheels and looks much like a T cart. A buggy is a light four-wheeled carriage, usually with but one seat. It is called a top-buggy when it has a calash top, and an open buggy when it has no top. In England a light chaise is called a buggy. A phaeton is something like a buggy, but is hung lower, so as to be easy for

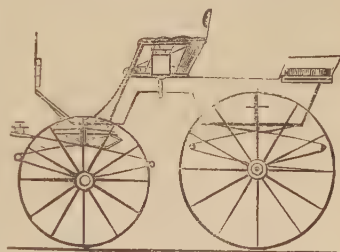


Brougham.

ladies and children to get in and out of. It has usually but one seat, but some phaetons have a rumble or servant's seat behind. In England phaetons are much used with two horses; in the United States they are usually drawn by one horse, but sometimes by a pair of ponies. The low carriages called basket wagons, made with a wickerwork body and an umbrella top, are sometimes called phaetons. A rockaway is a light carriage with a fixed top, or one which does not let down, and with either two or three seats. When with three seats, two of them are inside facing each other, and the other is used by the driver. There are a good many different forms of the rockaway, and it is much used, especially in the country.

A **Coupe** is a close carriage for two persons, with a separate seat for a driver. It is the same as a brougham, of which a picture is given, but differs from it in having a round glass front instead of a flat front.

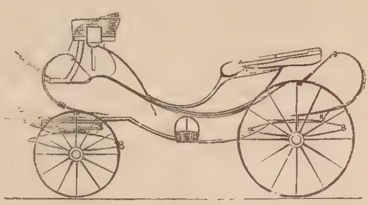
A landaulet is like a coupé, but



T Cart.

its glass window in front is so made that it can shut down into the woodwork, while the frame falls forward on each side of the driver's seat, and the back part of the top, which is leather, shuts down like a buggy top, thus making it into an open carriage. A coupelet is the same as a landaulet, but it is open in front.

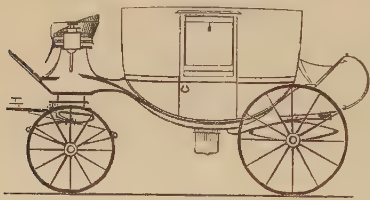
A **T Cart** is an open wagon with two seats, as shown in the picture. It is not quite so deep in the body as a French dog cart.



Victoria.

A **Victoria** is a light four-wheeled carriage, hung on a kind of springs

called C springs from their shape, which is shown in the picture. It has only one seat behind, for two persons, and a driver's seat in front, and it is fitted with a calash top. In the picture the top is down. The

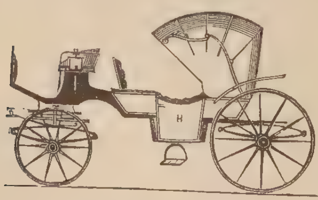


Coach.

victoria is much like the cabriolet, but differs from it in its springs and in the way the body is hung. It is often used with two horses.

The **Coach** is usually made with a close wooden body, like that shown in the picture. The doors, opening on each side, have a window at the top, which may be closed tight with a glass and a curtain. When open the glass shuts down into the panel of the door. The coach, which has two seats inside facing each other, is much used by ladies who wish to ride without being seen, and in making calls. A clarence is much like a coach, but has a rounded glass front.

A **Barouche** or brett has a falling calash top behind, but is open in

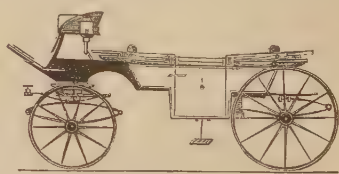


Barouche.

front. The seats are like those in a coach, but the front seat is often made with a back which shuts down, as shown in the picture, so as to cover up the front seat. This is usually done when only two persons ride in a barouche.

A **Landau** is shaped much like a coach when closed, but the top is made of leather so that it can be let down both in front and behind. The landau in the picture is shown open. A glass-front landau has glass windows in front and on the sides by the front seat. The windows are so made that they will shut down into the panels, and then the frame which holds them can be let down just as in the leather front landau. Sometimes this kind of landau is used with the glass front up and the leather back down.

The **English Coach,** or drag, sometimes called four-in-hand, because it is drawn by four horses, is a large vehicle, built somewhat like a stage-coach, with seats inside and outside. The owner and his friends

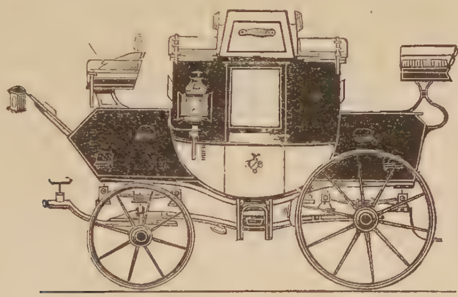


Landau.

ride on the outside, and if servants besides the footman are taken, they are put inside. A very good form of the drag is shown in the picture, which is one made in New York. This kind of carriage is much used by gentleman drivers who wish to carry large parties on the road or in the park. It is very handy for lunch and picnic parties, being fitted with boxes for carrying lunch baskets, wines, etc. The square box on the top, which is called the "imperial," can easily be made into a table.

Carriage Making takes a great deal of knowledge and skill, and only the best of workmen are employed in the business. As carriages have to be both light and strong, and used in all kinds of weather, they must be made of the toughest and best seasoned timber, and their parts fitted together with great care. The

frame is usually made of ash or of hickory, the planking of elm, and the panels of poplar, cherry, Spanish cedar, or mahogany. The work has to be joined together as carefully as cabinet work. What are called the running parts of the carriage, or the wheels, axles, etc., are made by a different set of workmen from those who make the body. The naves or hubs of wheels are usually made of elm, the spokes of light carriages of hickory, and of heavy ones of white oak, and the felloes or outside rim of oak or ash. Omnibus wheels, which have to stand much bumping, are made of all white oak. All parts of a carriage are fastened with pieces of the best iron and steel, the springs and parts of the axles are made of fine steel, the tires of the wheels, the braces, and many other parts of iron, though tires are sometimes of steel, and the ornamental metal work of silver or gold plate. Wheel tires are sometimes cushioned with india-rubber to make them noiseless, but the rubber makes harder work for horses and soon wears out. The leather work is done with great care and is made of the best material. The painting of the body in fine carriages takes much time and skill. Fifteen or sixteen coats of common paint are first put on and dried to make a body. Each one is left to dry and is then rubbed smooth with pumice-stone; the colors and ornaments are then put on, and when these are dry the whole is covered with five or six coats of copal varnish. The inside of a carriage is finished with fine cloths, silks, damasks, plushes, leather, and lace, and the work has to be as carefully done as the finest of furniture upholstery. To make a first-class carriage requires from four to six months of skilled labor.



English Coach, or Drag.

The word carriage is from the old English *caroche*, from Latin *carrus*, cart.

Hackney coach is from the French *coche-d-haquenée*, a carriage drawn by a hackney, a horse kept for hire.

Cabriolet, usually shortened into cab, is from the French *cabriole*, a goat leap or caper; the carriage was so named on account of its lightness.

Omnibus, often shortened into bus, is a Latin word meaning for all.

Gig is from the French *gigue*, a jig or lively dance, named from its motion.

Chaise is from the French *chaise*, a chair.

Sulky is so called because the person using it is said to be sulky, from wishing to ride alone.

Coupé is French, and means cut off, from *couper*, to cut; so called because a coupé is like a coach with the front cut off.

Brougham, named after Lord Brougham.

Landau, named from the town of Landau, in Germany.

CARROT, the root of a plant which grows wild in the countries around the Mediterranean, but is now cultivated in most parts of Europe and the United States. Carrots are used in soups and stews, and are highly valued as a food for horses and cattle. In Germany they are sometimes cut up into small pieces and roasted, and used to make a drink to take the place of coffee.

The word carrot is from the Latin *carota*, Greek *karoton*, a carrot.

CARTRIDGE. Before the invention of the metallic cartridge, cartridges for muskets were made of a tough paper called cartridge-paper. When the soldier wished to load his gun, he bit off part of the paper at the end which held the gunpowder, so as to uncover it, and then put the cartridge into the muzzle of his gun. He then drew the ramrod out of its place, put it into the barrel, and rammed the charge down to the bottom. The hammer of the lock was next drawn back and a percussion cap put on the nipple, and the musket was ready to be fired.

Although soldiers were taught to do these things quickly, much time was spent in loading, and not more than two shots could be fired in a minute. In 1858 George W. Morse, of Lowell, Massachusetts, invented a new kind of cartridge, with a metal case, for breech-loading guns. It was sent to England and tested by the government, but declined because it was not believed that any cartridge with the percussion cap attached was safe. Yet this kind of cartridge is now in universal use in all the armies of the world. The case of the metallic cartridge, commonly called the "shell," is made of a thin brass or copper tube, with a kind of flange at one end and open at the other. The percussion powder is put into the flange, the gunpowder on top of it, and the bullet is then fastened in securely and so tightly that the cartridge may be put into water without danger of wetting the powder.

The cartridge fired in the Springfield rifle, the gun used in the United States Army, is shown in the illustration.

Springfield Rifle Cartridge.

In it, *a a* is the brass shell, *b* the ball, *c* the powder, and *d* the flange containing the percussion powder. In loading his gun the soldier merely opens the breech end, pushes in a cartridge, and closes the breech again, when it is ready to be fired. In opening the breech to put in another cartridge, after firing, the brass shell which held the powder and ball is thrown out. Shells can be loaded again, if necessary, and sportsmen often reload them, but the shells of military rifles are generally thrown away.

Cartridges used in cannon are round cases made of flannel, just large enough to fit the bore of the gun. They are made of all sizes from those holding a few ounces of gunpowder up to those containing 300 to 400 pounds. Cartridges for machine guns are metallic like those used in rifles; those for rapid-fire guns are similar, but much larger.

The word cartridge, formerly spelled cartrage, is from the French *cartouche*, a cartridge, from Latin *carta*, paper.

CASHMERE, cloth made of the wool of the Cashmere or Thibet GOAT. What are commonly called camel's hair or India shawls are not made of camel's hair at all, but of the fine wool of a kind of goat raised in Asia, chiefly in Thibet and Tartary. The wool is sent from those countries into Cashmere, where a large part of the people are employed in making it into shawls. It is first bleached and spun into yarn by women, and then dyed of various

colors. The dyed yarn is bought by merchants, who give it out to weavers, who make it into shawls in their own houses. The workmen get only a few cents apiece a day, but as it takes two to four men a whole year to weave a single shawl, these shawls are very costly. A fine double one, or one usually called in the United States a long shawl, sells for $200 to $2000, but single or square shawls are cheaper. Plain shawls are woven in a LOOM with a SHUTTLE, but figured shawls are worked with wooden needles, each color taking a separate needle. In some of the richest shawls, three weavers can make scarcely more than a quarter of an inch in a day; but in order to do the work quicker shawls are made in many pieces by different workmen, and then put together with so much care that the seams cannot be seen.

Cashmere shawls are now made in France, in Paris, Rheims, Amiens, and Nîmes, which are so nearly like those made in India that it is almost impossible to tell the difference, and many are sold for the real shawls.

CASSAVA, an American plant from the root of which TAPIOCA is made. It was cultivated in Mexico and Central America long before the Spaniards came, and it is now common in all the warm parts of South America, and in the West Indies and Florida. It has also been carried to Africa and Asia, and large quantities are grown in the Straits Settlements. In Brazil and Paraguay it is called *manioc* and *mandioca;* in Peru, Ecuador, Bolivia, and Guatemala, *yuca*; and in the United States, and the West and East Indies, *cassava*. There are two kinds, the sweet, which is harmless, and the poisonous, which also becomes harmless when the juice is pressed out. The plant grows nearly as tall as a man, and has five or six roots ten to twelve inches long and two to three inches thick.

In South America the Indians grate the roots, drain the juice, and make the dried paste into a meal called *farinha*, out of which they make cakes and a sort of bread called *chipa*. By washing the paste in a sieve the pulpy part is dissolved, leaving little grains which, when dried, become TAPIOCA. The sweet cassava is much used as a vegetable boiled like the potato, or served in soups; cattle are very fond of the roots and grow fat on them.

The word cassava is from the Spanish *casabe*, Haytian, *kasbi*, the cassava plant.

CASSIMERE, or **KERSEYMERE** (perhaps same as Cashmere), a kind of woollen CLOTH, woven with a twill, in which it differs from broadcloth. The twill may easily be seen on the under side, where the nap is not raised.

CASTOR OIL, an oil pressed out of the seeds of the castor-oil plant, which first grew in Abyssinia, Sennaar, and other hot parts of Africa, but is now cultivated in most warm countries. In India the plant is sometimes a tree four or five times as high as a man, but in Europe and the United States it is usually a shrub not quite so tall as a man. It has large, broad, purplish leaves, and is often raised in gardens as an ornament under the name of Palma Christi or palm of Christ. The seeds, of which three grow in each pod, are about the size of a small bean, and have a smooth and beautifully marbled skin. In making the oil they are first bruised and then pressed cold; the oil is allowed to stand and settle for some time, or is filtered (see FILTER), to clarify it. Much castor oil is made in France and Italy, where it is used both as a medicine and for burning in lamps. The plant is largely raised in Illinois, and a good deal of oil is pressed in St. Louis and other Western cities.

Castor oil is so called from its resemblance to castor, a yellowish-brown substance got from the beaver, and used in perfumery.

CAT. It is not known exactly where the common house cat came from, but it is thought by most people to have sprung from the cats of the ancient Egyptians. Herodotus, the historian, tells much about these cats. He says they were greatly loved and tenderly cared for during life, and after death their bodies were preserved like those of human beings and buried in tombs. Many mummied cats' bodies are found in the graveyards of old Egyptian cities. In 1890 an Arab accidently fell into a pit near Benni Hassan, which proved to be a cave filled with tens of thousands of mummied cats, each one separately embalmed and as carefully wrapped up as if it had been a human body. Twenty tons of them, numbering about 180,000, were sold at Alexandria and shipped to England to be

Mummied Cats.

used for manure. The picture shows the heads of two of these cats, embalmed more than three thousand years ago.

Some of the old Egyptians worshipped cats, and if a boy killed one with a stone or by setting a dog on it, he would probably have been hanged at once by the angry people. In Persia, too, cats have been much thought of from the oldest times, and in some places cat hospitals were built where sick pussies could be taken care of. The Arabs love cats and keep them as pets. An old Arab once told a traveller that when Adam and Eve were driven out of Paradise, God gave them two friends to defend and comfort them, the dog and the cat. In the body of the dog he put the soul of a brave man, and in the body of the cat the spirit of a gentle woman; and this is the reason why the Arabs have always loved these animals.

There are many kinds of cats. Among the handsomest is the Spanish or tortoise-shell cat, which lives mostly in the south of Europe. Its colors and markings are like those of tortoise shell. The Angora cat, from Angora, in Asia Minor, has long brownish-white or slate-colored silky hair, and the Persian long white or gray hair and a bushy tail. The Maltese or Chartreuse cat is bluish-gray; the Chinese cat has long, silky, hanging ears; and the Manx cat of the Isle of Man has six instead of five claws on each foot, and no tail. The animal called the wild cat in North America is a kind of LYNX; the true wild cat lives in the wooded parts of Europe, but not in this country. The common house cat will sometimes become wild and live in the woods like other wild animals, but it will not become a real wild cat. The house cat often shows fondness for its master, but not so much as the dog, and it is more apt to show affection for its home than for the persons with whom it lives. When carried away to a strange place at a long distance from its home, a cat has been known to find its way back, although it had never been over the road before; and sometimes when a family has removed to a new home the cat has stayed behind, preferring the old house, even with strangers in it, to a new one with its friends. Cats love a warm and comfortable place, and will sit by the hour in the chimney corner with eyes half closed and showing their delight by a soft purring. They usually go in dry places and are careful not to wet their feet or their fur, which has nothing oily about it and is therefore easily wet. But although they do not like water, they can swim well, and will often go into the water to

catch fish. I have heard of a cat that would watch beside the sea for fish just as it would for rats beside a rat-hole, and on seeing a fish would dive in all over and bring it out alive. Another pussy used to go trout-fishing with her master, and would sit and watch until a trout was landed, when she would spring upon it and kill it. At other times she would fish for herself, running along the bank with her eye on a trout until she saw it stop, when she would dive down like an arrow from a bow and seize it. She would also catch water rats in the same way.

The eyes of the cat are so made that it can see with very little light, and it delights in prowling around in the night time, watching for prey. It will often sit for hours by a hole, waiting patiently for a mouse to come out. When it catches a mouse, it usually torments it before killing it, letting it go a little way and then pouncing upon it and catching it again. But when a cat catches a bird, it kills it at once, as if it knew that the bird could get away easier than the mouse.

Though cats love to catch mice, they seldom eat them unless they are very hungry. They like fish better than anything else, and the flesh of birds better than that of four-footed animals. They are great enemies to birds in the breeding season, and catch many young ones when they are just ready to fly. A cat once found a bird's nest in the gable of an old barn. There were five eggs in it, but pussy did not want these; she preferred to wait for them to hatch. She was seen to go, sometimes as often as three times a day, and peep into the nest. At last she was rewarded for her long watch, for as soon as the birds were hatched she ate them. Country cats are often great hunters, and catch, besides birds, hares, rabbits, weasels, moles, and other small quadrupeds.

Cats were very scarce in Britain in old times, and laws were passed for the punishment of persons who stole or killed them. If anyone killed the cat which guarded the prince's granary he had to pay a fine of as much wheat as would cover the cat when hung up by the tail with its head touching the floor.

Cats may be easily taught many amusing tricks. Begin to train them when young, and teach them first to love you. Any cat can jump well, but it can be taught to make wonderful leaps. Put little pieces of meat at different heights, and let it jump for them. It will soon learn to spring seven or eight feet. I have heard of a cat which would jump from the floor to the top of a parlor door and bring down a piece of meat on the top of it. You may easily teach a cat to jump through your arms by first holding them low and making it jump through them both ways, and then holding them a little higher day by day. It will become so expert in time that it will jump through your arms when held above your head. In the same way a cat may be taught to jump through hoops of different sizes and held at different heights. To teach a cat to jump through a hoop covered with tissue paper, the paper must first be oiled so that it can be seen through; but puss will soon learn to go through plain paper. Cats may also be taught to turn somersaults, to lie stretched out as if dead, to give a paw as if shaking hands, to open and shut the eyes at command, or to sit up on the hind legs and beg as little dogs are often taught. Always give your cat something to eat and drink after each lesson; it will remember it and be a better scholar for it. At such times it will like water better than milk.

Cats' skins are used for making sleigh robes and rugs, and for rubbers for electrical machines. In dry, frosty weather much ELECTRICITY may be waked up by rubbing a cat's back with the hand.

The common cat is a MAMMAL of

the order *carnivora*, or flesh-eating animals, and of the same family with the LION, TIGER, LEOPARD, PANTHER, JAGUAR, COUGUAR, and LYNX.

The word cat is Anglo-Saxon, from the New Latin *cattus*, *catta*, a domestic cat.

CATALPA, a kind of tree which grows wild in the southern parts of the United States and in the Mississippi valley. It is often fifty feet high, has silvery-gray bark, large heart-shaped pale green leaves, and bears white flowers tinged with violet, succeeded by pods a foot long. In England and other parts of Europe it is cultivated in gardens, and it is frequently seen in parks in Northern cities in the United States, but it does not grow so large as at the South. Its wood is fine, and is used in cabinet-making.

Catalpa is said to be the name given to this tree by the Indians of Carolina.

CATBIRD. The catbird, which belongs to the same family as the mocking-bird, is found only in North America. In the United States it spends the winter in the South, and comes North in April and May. It is more slender than the robin, and is dark gray or slate-color above and bluish-gray beneath, with head and tail brownish-black. It mews only when angry or frightened. It hates cats and snakes, and may often be seen, when one of these is around, sitting on a twig, mewing and jerking its tail from side to side. But it can sing also very sweetly, and can imitate the songs of other birds, though not so well as the mocking-bird.

The catbird builds its nest of

Caterpillar of Carolina Moth—Western Tobacco Worm.

twigs, mixed with leaves, weeds, and grass, generally in the middle of bramble bushes, and lays four to six greenish-blue eggs. It is very fond of its young, and will often feed and bring up the young of other birds. Its food is chiefly insects, worms, fruit, and berries. Catbirds are often persecuted by boys, but they ought to have the best of treatment, for they help the farmer by destroying grubs, worms, and wasps and other insects much more than they hurt his fruit and berries.

The catbird belongs to the order *insessores*, or perching BIRDS, and to the thrush family, to which also belong the MOCKING BIRD and the American ROBIN.

The catbird is so called because it sometimes mews like a half-grown cat.

CATERPILLAR, the common name of the larva or worm which finally turns into the butterfly or moth. In the article BUTTERFLY is

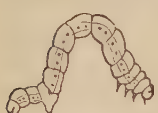
Butterfly Caterpillar.

told how the larva or caterpillar is hatched from the butterfly's egg by the warmth of the sun. There are as many different kinds of caterpillars as there are kinds of butterflies and moths, and there are also

as many differences between them. They vary much in size, being generally about an inch long, but some are much larger and some are smaller. Some have smooth skins and some are covered with hairs; some spin large nests in trees where they live in societies, some roll up leaves for houses, and some burrow in the ground or into leaves, twigs, and fruits; some feed on leaves, some on flowers, some on seeds of fruits, and some on roots. Butterfly caterpillars have usually sixteen legs, while those of moths vary from ten to sixteen. Some caterpillars have no legs in the middle part of the body, and move by drawing themselves up in arches or loops, like the canker worm. They are hence called spanners, loopers, or measuring worms. Some lead a solitary life,

Moth Caterpillar rolled up in Leaf.

and have nothing to do with others, though they may live on the same tree, and some always live together and go in regular processions when they leave their nests.



Measuring Worm.

The size of the caterpillar when hatched is very large for the egg from which it comes, and it grows very fast. It eats much more in proportion than any of the large animals, devouring sometimes twice its own weight of food in a day. It is this which makes it so harmful to plants and growing crops. It changes its skin several times during this stage.

Pupa of Butterfly.

Before turning into a butterfly or moth, the caterpillar becomes a pupa or chrysalis (Greek *chrusos*, gold), so called because many kinds have bright golden colors. The chrysalis of the butterfly is usually pointed and has little warts over its surface, but that of the moth is oval and smooth. When the time comes for the caterpillar to change into a chrysalis, it ceases to eat and hangs itself to the under surface of something, generally a leaf, either by its legs or by a thread of silk which it spins. It

Pupa of Moth.

now changes its skin for the last time, and if it is a butterfly chrysalis the new skin dries, covering the caterpillar in a kind of horny covering. It eats nothing, and does not stir while in this state. If the weather be hot the chrysalis case bursts open in eight or ten days, but sometimes this does not take place until two or three weeks. The but-

terfly is now seen with his wings hanging downward. In a few days these grow to their proper size, the outside of the body hardens, and the perfect butterfly flies away to live on the honey of the flowers and to lay eggs to hatch more caterpillars, which in turn will pass through the chrysalis state and become butterflies.

Caterpillars have many enemies. Poultry and all other insect-eating birds feed on them, and many insects also eat them. If it were not for this they would increase so fast that a great deal of damage would be done to fruits, grain, and other vegetation. A single butterfly or moth will lay 200 to 700 eggs; and it often happens that a caterpillar nest in a tree will have in it more than five hundred caterpillars, all of which have come from the eggs of one insect. Sometimes these all live together until they have passed through the chrysalis state, and sometimes they separate before that.

The word caterpillar means hairy cat, being made up of *cat* and the Latin *pilosus*, hairy.

CATFISH, the name of a family of fishes, found mostly in the muddy bottoms of rivers and ponds. The common catfish of the New England and Middle States is called also bull-head, bull-pout, or horned-pout. It is usually eight or nine inches long, weighs one-half to three-fourths of a pound, and has a slimy skin, like that of an eel. Its color is blackish-brown on the back, lighter brown on the sides, and yellowish-white below. It has two fleshy horns on the top of the head between the snout and the eye, and four others on the lower jaw. The bull-head may be easily caught by fishing near the bottom with either angleworm or raw beef bait. It bites best just at dusk. Many think it the best of fresh-water fishes for eating.

The great lake catfish of the Northern lakes is olive-brown, has a forked tail, and is sometimes more than a yard long. Other kinds of very large catfish are found in the Western rivers, but their flesh is rather coarse.

The catfish is so called because, when taken out of the water, it makes a sound like the purring of a cat.

CATGUT, the material from which the strings of violins, guitars, harps, etc., are made. It is wrongly named, for it is not made of the guts of cats, but of those of sheep, and sometimes of those of horses, asses, and mules. The best musical strings are made in Italy, but many are made in France also.

The word catgut is supposed to come not from cat, but from kit, a fiddle; so catgut means fiddle-string.

CATNIP, a plant common in the United States, so called because cats are very fond of its leaves. They have a somewhat sharp and bitter taste. A tea made by soaking them in hot water is given as a medicine.

Catnip is a corruption of catmint, formerly called cat's mint.

CATTLE. The word cattle really includes all kinds of domestic animals, such as cows, oxen, horses, mules, sheep, goats, and swine, but in the United States it is generally taken to mean horned cattle only, such as bulls, cows, and oxen, and it will be used in this way in this article. In England horned cattle are commonly called neat cattle.

There were no cattle in America when it was discovered by Columbus; but the Spanish settlers brought over bulls and cows with them, and now all the great plains of South America are covered with herds of wild cattle descended from them. These cattle are large, long-legged, and have very long, branching horns. Most of the cattle in California and in Texas also are descended from early Spanish cattle. The common cattle in other parts of the United States are descended from bulls and cows brought from Eng-

land by the early colonists; but in many places these have become mixed with other breeds brought to this country at a latter date. All common cattle are usually called natives. From them we get most of the BEEF which we eat, and many of the cows are as good for giving milk as some of the foreign breeds.

Among the most valuable of the foreign breeds, which have been brought to this country mostly in this century, are the Durhams, the Ayrshires, and the Alderneys. The Durhams, named from Durham County, England, whence they were first brought to the United States, are usually called short-horns here, on account of the shortness of their horns, but in England they are known as the Holderness breed. They are usually dark-red pied with white, and are noted for the quantity and richness of their milk, and for the fineness of their beef. In the Western States they are the favorite breed. The Ayrshires, first brought from Ayrshire in Scotland, are generally piebald, that is, of mixed colors, most brownish-red, yellow, and white. They are highly prized for their milk, but not so much for beef, and they do not fatten easily. The Alderneys or Jerseys, brought from Alderney, one of the Jersey or Channel Islands, off the north coast of France, are commonly light red or yellow mixed with white, and are small and graceful in form. They give very rich milk, but not so much as the Durhams, and as they are not as good for beef as some other breeds, they are not thought to be very profitable. But they are often kept in private dairies on account of the richness of their cream, and of their gentleness and beauty. Devon cattle, from Devonshire, England, are a handsome, dark red breed, which make fine oxen.

In Northumberland County, in the north of England, in the park of Chillingham Castle, are kept many wild cattle. They are rather small, with straight backs, short slim legs, and fine forms, and are all of the same color, creamy white all over, excepting that the tips of their horns, their hoofs, and the ends of their noses are black, and the insides and a part of the outsides of their ears are reddish brown. They are very timid and will run like deer, and sometimes they will go into the depths of the forest and hide for weeks at a time. These cattle are supposed to be the descendants of the wild cattle that lived in the forests of the north of England and Scotland in ancient times. There is another herd at Hamilton Castle in Scotland, which are like those at Chillingham, but have black instead of red ears.

The word cattle comes from the New Latin word *captale*, capital, property, or goods, because in old times cattle were the principal goods of everybody. Our word chattels comes from the same word.

CAULIFLOWER. See CABBAGE.

CAUSTIC, any substance used by physicians and surgeons to burn or eat away skin or flesh, when sore or diseased. The principal caustics are lunar caustic (SILVER nitrate), so called because *luna* (Latin, moon) is the old name for silver; NITRIC ACID; copper sulphate or blue VITRIOL; and caustic POTASH.

The word caustic is from the Greek *kaustikos*, that which burns, from *kaiein*, to burn.

CAVE. Natural caves or caverns have been formed in several ways. Some have been made by the sea, the wash of currents, the force of breakers, and the grinding of sand and gravel thrown up by waves gradually wearing out the weak places in cliffs and making hollows in them. Fingal's Cave, on the island of Staffa, off the southwest coast of Scotland, was cut out in this way. In volcanic regions caves have been formed by the upheaval of the earth and by the expansion of steam and gases in melted lava. Caves of

this kind are to be seen around Vesuvius, Etna, and other volcanoes. The Grotto del Cane (Dog's Cave), near Naples, was thus formed. A third kind of cave has been made by fresh water, both by friction and by the eating out of the rock by some chemical substance in it. Such caves, which are the most numerous of all, are found in countries underlaid with limestone. The famous Franconia Caves in Germany, the Mammoth Cave in Kentucky, Luray and Weyer's Caves in Virginia, and many others in the United States are of this kind.

In the article EARTH is explained how water that runs down into the earth in crevices wears away the rocks little by little, and enlarges the hollows until in time caves are formed. In limestone rocks this wearing away is helped by the CARBONIC ACID which is mixed with rain water. This carbonic acid is got partly from the air by rain in passing through it and partly from the surface soil through which it filters. When the water finally reaches the limestone, or carbonate of lime (CALCIUM carbonate), the carbonic acid eats into it and mixes with it, changing the carbonate into what is called bicarbonate of lime, which is carried off in the water. It thus gradually eats away the rock, making the crevices and hollows larger and larger until caverns are formed, and sometimes long passages in which subterranean streams run. The limestone region in Kentucky is all honey-combed in this way with caves and channels for water, which finally comes to the surface and flows off as rivers.

The bicarbonate of lime thus formed by the action of the acid on the limestone now goes through another change. When exposed to a current of air the air takes from it much of its carbonic acid and the lime again returns to a solid state and forms the beautiful stony incrustations on the sides and roofs of caves as well as the fantastic pinnacles and pillars called stalactites and stalagmites. Stalactites (Greek *stalaktos*, oozing in drops), are lime formations, hanging from the roof of caverns like icicles, made by the continual dripping from cracks above of drops of limewater which evaporate (dry up) and leave the carbonate of lime again solid. What drips to the floor builds up also a column from below called a stalagmite (Greek *stalagmos*, dripping) which frequently grows until it meets the descending stalactite, thus forming a pillar which appears to support the roof of the cave. Sometimes the surface of pools in caves is covered with a sheet of stalagmite like ice, and sometimes little basins are formed beautifully polished inside and containing drops of lime carbonate that look like little pearls. Stalactites and stalagmites are often pure white, giving the cave a magnificent appearance when lighted by torches, but generally they are yellow or brownish, colored by the impurities taken up by the water from the soil. The caves most celebrated for beautiful stalactites are Adelsburg in Carniola and Luray in Virginia.

Only part of the carbonate of lime taken from limestone rocks is thus deposited again in the hollows from which it came. The rest flows into streams which pass into the open air and finally into the ocean, where it goes to make the coverings of MOLLUSKS and other shell fish. It is thus collected again in solid form and is in time packed away in a mass at the botton of the sea to be again raised up in the course of ages as limestone rock. So it goes on forever, the land giving it to the sea and the sea giving it back to the land just as in the beginning of the EARTH, when the limestone was made in this way at the bottom of the ocean and first lifted above the waters as ROCKS.

Bone Caves. Caves are very interesting also from the bones of ani-

mals and of men which have been found in them. These are imbedded in mud on the floors and sometimes even covered with the lime drippings. Among the animal bones found in Great Britain, France, Germany, and other parts of Europe, are many of extinct animals such as the mammoth, the woolly rhinoceros, the hippopotamus, the hyena, and the lion, which shows that the climate was very different in the times when they lived. The finding of flint and bone weapons and tools among these bones shows too that man lived there at the same time with these animals. These implements—such as spear-heads, arrow-heads, hammers, axes, and saws made of flint, and needles and awls made of bone—are like those in use by the Eskimos of the Arctic regions to-day, and lead us to think that the first people who lived in what are now the most civilized parts of the world were rude savages, supported by hunting and fishing, who were clothed in the skins of wild beasts, and who did not know how to spin or to make pottery. Similar bone caves have been found in America, Australia, and other parts of the world. All we know about them is derived from the few things found in them, for they belong to almost the earliest ages of the world, even before the Stone AGE. Bone caves have been found in France, England, Belgium, Spain, Italy, Switzerland, in North, South, and Central America, Australia, and other parts of the world.

Prehistoric Caves. Caves used by man in prehistoric times—that is in times before the beginning of history, when men kept no records, are commonly called by this name. They differ too from those told about above in that they contain the bones of domestic animals and those of wild animals of kinds now living, while the bone caves proper contain only the bones of animals now extinct. Prehistoric caves are therefore much later than bone caves, and represent a time when man had begun to be civilized. They are divided into three groups—those of the Stone AGE, of the Bronze Age, and of the Iron Age, according to the things found in them left by the men who lived in those ages. Caves of the Stone Age are found all over Europe. They were used both as dwellings and as places of burial; the skeletons found in them show that the men were a short race much like the Basques now living in Spain. Caves of the Bronze and Iron Ages are seldom found, because man had then learned to build houses, which he preferred to caves.

Historic Caves are those in which men have lived in historic times, when forced to flee to them for refuge in time of war or other calamity. Many caves in Britain were thus occupied when the savage Angles and Saxons swept over the land, and very interesting things have been found in them, throwing light on the history of the times.

The word cave is from the Latin *cavea*, a cave, from *cavus*, hollow.

CEDAR, the name of several kinds of evergreen trees. In the United States the white cedar abounds south of Massachusetts and Ohio. Its wood, which is light red, is valued for making fence posts and shingles. The red cedar grows in most parts of North America and in the West Indies. Its wood is bright red, hard, and lasting. It has a pleasant smell, which is not liked by insects, and it is therefore much used for making chests and closets to keep clothes in. It is also used in cabinet work and for making lead pencils. The best red cedar for lead PENCILS is brought from Florida. Spanish cedar, of which cigar boxes are made, is a kind of mahogany. It also is used sometimes for lead pencils.

The cedar of Lebanon is a very large tree, which grows in the coldest parts of the Lebanon mountains in

Syria. Its wood was much sought in ancient times for building, but the trees are now scarce. It has been planted in parks in many parts of Europe and may be seen in England, where it was first taken in the seventeenth century.

The word cedar is from the Latin *cedrus*.

CELERY, a plant of the parsley family, used chiefly as a salad and to flavor soups. It grows wild in Eastern Europe, Western Asia, and Northern Africa. In its wild state it is said to be rank and poisonous, but by cultivation it becomes healthful and pleasant to the taste. The stalks are not naturally white, as we usually see them, but are bleached while growing by heaping the earth up around them nearly to the leaves.

The word celery is from the Greek *selinon*, wild celery, which is mentioned in the Odyssey.

CELLULOID, a substance made out of gun cotton, camphor, and some other things. When white, is so much like ivory that it has taken its place for many uses, and it has seriously injured the business of ivory manufacturers. Even billiard balls are now made of it, at half the cost of ivory, and it is very largely used for piano and organ keys. Combs and brushes, the backs of hand mirrors, the handles of knives and forks, harness-trimmings, chessmen, collars and cuffs, and numerous other things are made of it. It has taken the place of india rubber too for whip, cane, and umbrella handles, and for pencil cases and jewelry, because it does not tarnish metal. It can be colored like tortoise-shell, coral, malachite, and amber, and used instead of them for mouthpieces of pipes, cigar-holders, and opera-glasses; and it also makes good plates for photographs and miniatures. All the celluloid used in the United States is made by one company in Newark, N. J., and sold to other companies who manufacture it into the various articles made of it. The Newark company has branches also in London and Paris.

Celluloid is a word made up of cellulose, a certain part of the fibre of plants, and the ending *oid*.

CEMENT, any substance used to make bodies stick to each other, such as GLUE, MORTAR, etc. The ancient Egyptians made a kind of mortar out of Nile mud and gypsum. The Babylonians used a cement made of bitumen. The Greeks were very skilful in making cements, but the Romans were superior to them, and their water cement was as good as any now made. It was made of pozzuolana, a kind of lava found at Pozzuoli, near Naples, and lime. What is now called Roman cement is not exactly like the old Roman cement, but is made chiefly of a kind of limestone containing clay, which is burned, crushed, and ground. Portland cement is made from clay and chalk obtained from the valley of the Medway, in England. These and other similar cements which harden quickly under water are called hydraulic cements, and are largely used in building aqueducts, foundations for bridges, breakwaters, cisterns, and other works under water.

Many kinds of cement are used for mending broken glass, china, and earthenware. They are made of various things, such as Canada balsam, shell-LAC, copal or mastic VARNISH, ISINGLASS, india rubber, etc. Diamond cement, so called because it is used by Armenian jewellers in setting diamonds, is made of gum mastic and isinglass dissolved in spirits of wine. The white of egg, mixed with a little powdered quick LIME, makes a good cement for crockery.

The word cement is from the Latin *cæmentum*, rough stone or chippings of stone.

CENT. The first United States coin called a cent (1793) was made of copper, and was larger than the

present quarter dollar. A half cent, of half the size of the cent, was also coined. In 1857 the coining of the half cent was stopped, and a new cent, about as large round as a ten-cent piece but thicker, and made of eighty-eight parts of copper and twelve parts of nickel, was coined. In 1864 this cent was changed for the present BRONZE cent, which is made of ninety-five parts of copper and five parts of tin. The two-cent coins are also of bronze, and the three and five cent pieces are three parts copper and one part nickel.

The word cent is from the Latin *centum*, a hundred; and the coin is so called because there are a hundred in a dollar.

CHAIN. The picture shows how common chains are made. Pieces are cut off of iron rods of the right

Fig. 1.—Iron Chain Making.

size, as in *a*, bent round as in *b*, and then put together as in *c*. Sometimes the links are only bent together, but in strong chains the ends are welded—that is, they are heated white hot and hammered together until each link becomes a solid ring, Chains are made of many sizes, from dog chains with small links of wire to the great CABLES for ships with links as large as a man's waist. Still larger ones are sometimes made and stretched across rivers and the mouths of harbors in war-time to keep out an enemy's ships. Such a chain was put across the Hudson River near West Point in the Revolutionary War to keep the British ships from passing up. Each link of this chain was about two feet long and weighed as much as a medium-sized man (140 pounds). Some of the links are still at West Point.

Chains are now made of steel without any welds, each link being entirely solid. The links are cut by several processes out of a long bar of rolled steel, the cross section or end of which is shaped like a four-pointed star, as in Fig. 2. Holes are

Fig. 2.—End of Bar.

cut through this down its sides to mark the length of the links, which are then pressed and stamped out, as shown in the cut (Fig. 3), much as a boy would cut a chain out of wood. After being separated the links have to be trimmed and smoothed. They can be made of any shape or size according to the die used. Chains thus made are 40 or 50 feet long, and are without a break in the links. They are much lighter and stronger than iron chains.

An endless chain is a chain with the ends fastened together so as to form a chain ring without any ends. Such a chain is used in the chain PUMP, where it turns round and round on two wheels or rollers, one at the top and one at the bottom; also in the DREDGE or machine for clearing mud out of the channels of

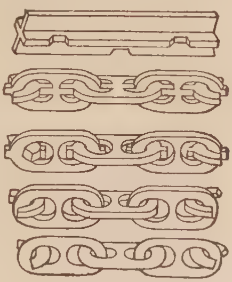


Fig. 3.—Weldless Chain Making.

rivers and harbors. Chain-shot is told about under SHOT and SHELL.

The word chain is in French *chiane*, and in Latin *catena*.

CHALK, a soft kind of limestone or carbonate of lime. It is made up almost entirely of the shells of little sea animals, which in the course of ages have become packed together so closely and in such immense quantities that in some parts of the world they form vast cliffs twenty times as high as a house. Though generally yellowish-white, its color is sometimes snow-white. It is usually soft, but is often hard enough to be used for building stone. When burned it makes good lime for MORTAR, and a good manure; and when ground and purified by washing it is called whiting or Spanish white, used for polishing metals and glass. Chalk is given as a medicine and is used for cleaning the teeth; it is also largely used for marking on black-boards.

Black Chalk is a mineral different from white chalk. It is a kind of clay, colored with CARBON, and is usually found near or in coal mines.

Red Chalk is also a kind of clay, colored with oxide of IRON. The coarser kinds are used by carpenters for marking on wood, and the finer kinds by artists. It is found mostly in Germany.

French Chalk is a kind of SOAPSTONE. It is used by tailors for marking on cloth, by glaziers to mark on glass, and in the manufacture of porcelain.

The word chalk is from the Anglo-Saxon *calc*, which is from the Latin *calx*, lime.

CHAMPAGNE, a kind of sparkling wine, made mostly at Rheims and Epernay, in France. The grapes are pressed in September and October, and the juice allowed to stand in large vats for twelve to eighteen hours. After the froth which rises has been skimmed off, the wine is drawn into barrels and left to ferment (see BEER). In December, when it is clear, it is again drawn off and several kinds are mixed together in vats, the flavor of the wine depending greatly on the way it is mixed. It is next drawn again into barrels and allowed to rest until spring, when it is bottled and corked. The bottles are put into cellars and laid on their sides. A second fermentation now takes place, which bursts about ten and sometimes twenty bottles in every hundred. After this is finished the good bottles are restacked and allowed to lie for a year and a half, when a thick sediment or scum is found to have settled in the neck of each bottle. The bottles are then uncorked and the sediment poured out, when all are refilled with fresh wine and recorked. Champagne made in this way is what is called *sec*, or dry wine, which means that it has no taste of sugar in it; but that which is to be sent to foreign countries usually has some melted rock candy mixed with brandy put into it, and is then called *doux*, or sweet. Wine made still sweeter by the addition of liqueur, is called *brut*. The corks are now fastened with wires and covered with wax or tinfoil to keep out the air. Champagne, when sold, is always two or three years old. A great deal of false champagne is made in this country out of cider and other things.

Champagne got its name from the old province of Champagne, France, where it was first made.

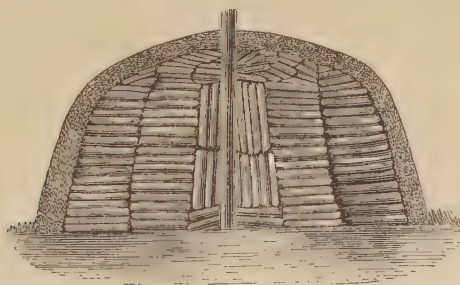
CHAMELION. See LIZARD.

CHAMOIS. See ANTELOPE.

CHARCOAL, coal made by charring wood. In making charcoal sticks of wood are piled up in great round heaps, with a hole left in the middle for a chimney, as shown in the picture. Another hole is left from the outside of the heap along the ground to the bottom of the chimney, so as to let the air in and make a draught. When the wood is all piled up the spaces between the logs are filled with chips, twigs, and leaves, so as to make the pile even all over, and it is then covered with sods and earth. The heap is now fired at the bottom of the chimney,

and the fire spreads little by little all through the wood, care being taken to make holes around the outside now and then, to give it air, and to put on more sods and earth to keep the wood from blazing. The heap, which is called a coal-pit, because charcoal was first burned in pits dug in the ground, has to be watched night and day, for it is only by keeping the air almost entirely away from the wood when it is burning that we can make charcoal. The reason is this: wood is made up mostly of CARBON mixed with water and some other things. Now charcoal is almost pure carbon; therefore to make it we must drive off from the wood the things with which it is mixed. This is done by burning it in a place where but little air can get to it. Some air must be let in, because fire will not burn without OXYGEN. If it would burn without air we could save all the carbon in it, but as it will not we can save only a part of it when we burn it in a coal pit. The rest mixes with the oxygen of the air and makes CARBONIC ACID gas. If the coal pit were not kept covered up so as to prevent the air from getting to all parts of it, its oxygen would mix with the carbon in the wood, and it would all fly off into the air, and we should get only ashes instead of charcoal.

When the whole heap of wood is



Charcoal Pit.

turned into charcoal, which takes about a week for small heaps and two or three weeks for larger ones, all the holes are closed up and the pit is left for one or two days to cool. It is then uncovered, part at a time, and the charcoal spread out in layers. This is usually done at night, so that if any of it is still afire, it may be easily seen and put out.

Wood charcoal is largely used as a fuel, especially in countries where there is no mineral or hard coal, and also for smelting metals. It has the power of absorbing or taking up smells and gases, and therefore is used to destroy the bad odor from decaying animal and vegetable matter, especially in sewers and drains. It also takes out coloring matter from liquids, and is much used in FILTERS for cleansing and purifying water, syrups, etc. Physicians sometimes use powdered charcoal in poultices for bad sores, as it has the power of cleansing them and keeping them from smelling. It is also given for indigestion and is used for tooth-powder. One of the most important uses of charcoal is for making GUNPOWDER. Animal charcoal is made by burning BONE, ivory, etc.

CHEESE, the curd of MILK pressed in a hoop or mould. In making cheese the curd or caseine of the milk must first be separated from the whey, or watery part. In the article MILK is explained how this takes place in sour milk. But as the

caseine of sour milk will not make good cheese, it must be separated from the whey while the milk is sweet. This is done by putting an acid juice called rennet into the milk. Rennet is the dried inner part of the stomach of a young calf. When needed for use a piece of it is soaked in water, and some of the water is poured into the milk, which has been warmed. In about an hour the caseine and cream will be found to have separated from the whey and settled to the bottom. This is caused by the ACID in the rennet, which turns the sugar in the milk into lactic acid, and this mixes with the caseine and curdles it. The curd thus made is then drained of the whey, salted, and pressed in a cheese press for two or three days, when it is put away in a cheese room to ripen. Some cheeses ripen in a few months, but some, like the Italian Parmesan, take two or three years. Cheeses are frequently colored with ANNOTTO. Parmesan cheese is colored and flavored with saffron, sage cheese with sage. The best English cheeses are the Stilton, Cheshire, and Cheddar. Gruyère cheese, made in Switzerland, is strongly flavored with herbs. The French Roquefort cheese is made from the milk of sheep and goats. Brie and Neufchatel (French) cheese are made of pure cow's cream.

Cheese has been made from the most ancient times, and it was a common article of food among the Greeks and Romans. The Tartars make cheese from the milk of mares, the Arabs from that of camels, and the Laplanders from that of reindeer.

The word cheese is from the Anglo-Saxon *cese*, which is from the Latin *caseus*, cheese.

CHERRY. The cherry tree is said to have been first carried to Italy by the rich Roman Lucullus in the year 65 B. C., but it is probable that he introduced only a new kind, for cherries had been known in Italy long before that time. The Romans had only eight kinds of cherries; but now more than three hundred kinds are known. The wild cherry, one of the largest of our forest trees, grows all over the United States. Its wood is fine and close grained, and of a reddish color, which grows darker with age. It is much used by cabinet makers. The fruit, which is nearly black and somewhat bitter, is much smaller than the common cherry, and grows in clusters on a stem. It is used for flavoring liquors, and its bark is used in medicine. Cultivated cherries are of many different colors, from light pink through many shades of red to black. They are used as dessert fruits, preserved and dried, and in making various cordials such as cherry brandy, and Maraschino and Kirschwasser cordials.

The word cherry is from the Latin *cerasus*, and the fruit was so called because the Romans first brought it from Cerasus in Asia Minor.

CHESTNUT, the fruit of a large tree which grows wild in Western Asia, Northern Africa, Europe, and the United States. The chestnut is a handsome, wide-spreading tree, and among the largest that grows. One on Mount Etna is so large that it would take sixty-five of a man's steps to go round it (160 feet). The timber of the chestnut is hard and lasting, and is much used in house building and in making furniture. Its bark is used in tanning leather, but it is not so good as oak bark. Its fruit grows in a prickly case, which splits open into four parts when frost comes, and lets the nuts fall out. Chestnuts are much eaten by squirrels, and they form a large part of the food of poor people in the south of Europe, being eaten raw, boiled, or roasted, or ground into meal and made into bread and puddings. The best kind of French chestnuts, called *marrons*, have only one large kernel, instead of two or three separated by a skin, like

most of the common kinds. A small kind is called chinquapin in America.

The word chestnut is shortened from chesten-nut, the fruit of the chesten tree, so called from the Latin *Castanea nux*, Castanean nut, because the Romans first found the tree growing at Castanea, a town in Pontus.

CHICORY, the wild endive, a plant belonging to the same family with the DANDELION. It grows in most parts of Europe, in Northern Africa, and Eastern Asia, and has been naturalized in the United States. Chicory has a thick milky root, which is cut up, dried, roasted, and ground, and used either for coffee or mixed with coffee. It looks like ground coffee, and though it makes a drink of a pleasant taste, it has none of the flavor of coffee. When much used it is often hurtful, making those who drink it very nervous. It is used also as a salad, as a vegetable, and for fodder. The Greeks and Romans ate it as a salad.

The word chicory is from the Latin *cichorium*, Greek *kichora*, chicory. Chicory also is sometimes called succory.

CHICKADEE. This little bird is sometimes called also black-cap, and sometimes snow-bird. It is ashy-gray on the back and brownish-white below. and the top of the head and the back of the neck are pure black. The chickadee is a lively little bird, and may often be seen running over trees and sticking its bill into every crevice, searching for insects. In this way it destroys vast numbers of canker-worms and grubs and does great service. In the winter it comes near houses, looking after crumbs and seeds, and it is lively in the coldest weather. It builds its nest usually in hollows of trees and lays eight or ten whitish eggs covered with brownish-red spots. The chickadee is found all the year round in almost all parts of the United States.

The chickadee belongs to the order *insessores*, or perching BIRDS, and to the warbler family, to which belong also the bluebird and the European robin.

The chickadee gets it name from its song, which sounds like chickadee-dee-dee.

CHIMNEY. The ancients had no chimneys; they seldom built fires in their houses, but warmed their rooms with live coals brought in a pan or in a small stove that was easily moved. Even in modern times, as late as Queen Elizabeth's reign, chimneys were found only in the houses of the rich. In most houses fires were built in a hollow place in the floor in the middle of the room, and the smoke went out of a hole left in the roof above it.

The reason why smoke goes up a chimney is that it is warmer than the air outside, and warm AIR always rises. Great care has to be taken in building chimneys. If they are too high and too large, especially in cold places, the heat may be used up before it gets to the top, and they will not draw well, but will smoke. The chimneys of factories are often built very high, but they are narrow for their height, and as very hot fires are kept up in the furnaces, the air within them is kept heated all the time. The higher the column of heated air is, the greater is the difference of weight between it and the air outside; the higher the chimney is, therefore, the greater the draught up it will be if the air in it can be heated hot enough. Such tall chimneys are also useful to carry off the bad gases and smells that rise from some kinds of manufactures, and would poison the air around them. The highest chimney in the world is at the Imperial Smelting Works at Halsbrücke, near Freiberg, Saxony: it is 459 feet high, or nine feet higher that the great pyramid, and four-fifths as high as the Washington monument.

House chimneys in cities sometimes smoke because higher build-

ings near them turn the wind and make it blow down their flues. Such a chimney is often cured by putting up a pipe from it higher than the building, or by putting a bent pipe on the top, fitted with a vane which turns the mouth of the pipe away from where the wind blows. This keeps the cold air from blowing down, and lets the warm air rise and go out.

The work chimney is from the French *cheminée*, which is from the Latin *caminus*, fire-place.

CHINCHILLA, a small animal found chiefly in the Andes of Chili and Peru. It is about as large as a squirrel, with a head like a rabbit's, with large black eyes, and ears nearly as long as the head. The hinder legs are longer than the front ones, and it sits on its haunches when eating, holding its food in its fore paws. It is valued for its fur, which is thick, soft, and gray, and is much used for cloak linings, trimmings, and other articles for ladies' and children's wear.

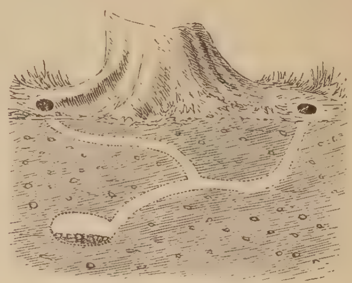
The chinchilla is a MAMMAL of the order *rodentia*, or gnawing animals.

The word chinchilla is Spanish.

CHINTZ, a kind of glazed printed calico, with a pattern in many bright colors. It is printed like CALICO and glazed afterward. Chintz is much used for covering furniture, and sometimes for bed and window hangings.

The word chintz is from the Hindu *chînt*, spotted cotton cloth.

CHIPMUNK. Chipmunks are sometimes called ground squirrels because they live in the ground, striped squirrels on account of the marks on their fur, and cheeping squirrels on account of the cheeping noise they make. The common chipmunk has a body five to six inches long, and a tail which is not so bushy as in other squirrels, and a little shorter. The fur is yellowish-brown mixed with gray above and white below, and the back and sides are marked with five black stripes running lengthwise. The feet are large and fitted with strong claws for digging. They burrow deep into the ground, usually under the roots of a tree or under a stone wall, and make a round nest at the bottom, generally with two entrances, as shown in the picture,



Nest of Chipmunk.

but sometimes with three or more. The nest is lined with fine grass, and in this the chipmunks live and bring up their young, of which they usually have four or five, born in May. Several other round places are dug near the nest later in the summer to store up food in for winter. Chipmunks have pouches inside their cheeks, in which they collect nuts and seeds, and when these are crammed full they scamper home and empty them. Besides nuts, berries, and acorns, they feed chiefly on Indian corn, wheat, buckwheat, cherry stones, and grass seeds, and all these things have been found stored up in their holes.

During July and part of August chipmunks do little but play, seeming to spend all their time from sunrise to sunset in galloping over the ground, fences, and walls, chasing each other like children playing tag, and trying to bite each other's tails. If a hawk happens to come in sight, every one stops wherever it happens to be, hoping that it may not be seen, but if one be near its hole, it will dart into that, run down to

the nest, then turn about and come quickly back to the entrance and peer around with its sharp little eyes until the danger is past. Sometimes one is caught by a hawk, but the WEASEL is the worst enemy of chipmunks, as it follows them into their burrows and kills them there. About the middle of August they begin to work in earnest, and they may be seen with their cheek pouches filled, looking like children with the mumps, carrying nuts and seeds into their store-houses. When the first white frosts come, they go into their nests and live on the food they have laid up until winter sets in, when they become numb, and lie so until early spring. With the first warm days they wake up again, and live on their stores until they can get berries and other food outside.

Chipmunks are easily caught in traps, but are not easily tamed, and do not make such good pets as gray squirrels. They are so restless in their habits, and enjoy their liberty so much, that it is cruel to shut them up in a cage.

The chipmunk is a MAMMAL of the order *rodentia*, or gnawing animals, and of the squirrel family.

The word is sometimes written chipmonk and chipmuck. It is said to be the Indian name of this kind of squirrel.

CHIPPING BIRD. See SPARROW.

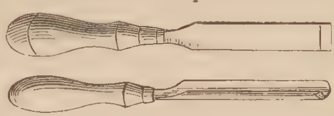
CHISEL. This is probably one of the most ancient of tools. Chisels of sharp FLINT have always been used by savages to cut wood, and in very early times bronze ones were made which would cut the hardest stone. The ancient Egyptians carved most of their granite monuments with COPPER or BRONZE chisels, which are said to have cut as well as the best steel chisels of the present day.

Chisels are now made in many different forms, and for many kinds of work. Those used by sculptors, masons, and other workers in stone, are merely short pieces of steel with sharp edges. The tool is held in the left hand and is made to cut by striking it on the end with a broad hammer called a mallet, made usually of wood. Blacksmiths and other

Ancient Bronze Chisels.

iron-workers use chisels much like those of stone-cutters, for cutting off bars of iron and like work.

Carpenters' and joiners' chisels are much finer tools, and usually have handles. They are made out of bar iron by forging, or hammering it while hot, and the edge, of cast STEEL, is put in in the same way as the edge of an AXE. Such chisels are made of many sizes, from an eighth of an inch up to several inches in width, and are used for different kinds of wood cutting and carving. DOVETAILS, MORTISES, and other such work are usually cut with chisels. A kind of chisel with a rounded blade, used for cutting grooves and round places in wood,



Carpenter's Chisel and Gouge.

is called a gouge. The picture shows the form of the carpenter's chisel and the gouge.

The word chisel is from the old French *cisel*, Latin *sciselum*, from *scindere*, to cut.

CHIVES. See ONION.

CHLORINE, a simple substance, or ELEMENT, of a greenish-yellow and a very strong, suffocating smell, of great value in the arts. In its

common form it is a gas, but it may be made into a liquid under great pressure and cold. Chlorine is found in minerals, vegetables, and animals, but always mixed with something else. United with SODIUM, it forms the chloride of sodium, or common SALT, from which great quantities of chlorine are made. This is mixed with slacked LIME to make chloride of lime, or bleaching powder, which is largely used for bleaching linen and cotton. Chloride of lime is much used in hospitals, sick-rooms, and other ill-smelling places to purify the air. Unlike burnt paper, vinegar, and scents, which only hide smells, chlorine destroys the substances which make them.

When united with the metals and some other substances, chlorine forms an important class of SALTS called chlorides. United with hydrogen, it makes hydrochloric or muriatic ACID. Chloral, used by physicians to make nervous people sleep, is made of chlorine and alcohol.

The word chlorine is from the Greek *chloros*, grass-green.

CHLOROFORM is a colorless liquid, of a peculiar smell and sweetish taste, much used in medicine to make people insensible to pain. When breathed it quickly puts one into so deep a sleep that a surgical operation may be suffered without feeling any pain. Chloroform is made up of CHLORINE, CARBON, and HYDROGEN. It is made by distilling (see ALCOHOL,) chloride of LIME, alcohol, and water.

The word chloroform is made up of *chloros*, grass-green, and *formyle*, a substance named from the Latin *formica*, an ant, because it was first found in ants.

CHOCOLATE, a paste made of the seeds of the cacao tree. The cacao tree grows well only in a very hot and very damp climate. It grows wild in the forests of the Amazon and Orinoco basins, and is cultivated chiefly in the hottest parts of Brazil, Central America, Mexico, and the West Indies. About 1675 it was carried by the Spaniards from Mexico to the Philippine Islands, where it grows well. It has been introduced also into the Sunda Islands. The cacao is an evergreen, usually three or four times as high as a man. It bears a fruit shaped like a thick, short cucumber, six to nine inches long and about half as wide. The skin is rough and warty; the inside is a sweet pinkish-white pulp, used for food, which contains twenty to sixty seeds, about as large as almonds. These seeds, which are called cocoa beans, have a thin, brittle, reddish-brown husk and a dark-brown oily inside.

In preparing cocoa beans for use they are first roasted like coffee beans. They are then bruised and winnowed or cleaned of the husks. The husks which are thus parted are the "cocoa shells" of commerce, and the beans, broken into pieces, are called "cocoa nibs." This is the purest form in which cocoa comes. The paste made by grinding the nibs alone is properly called cocoa, and that made by grinding them with other substances and flavors, chocolate. Pure cocoa is made up of nearly one-quarter STARCH and gum, about one-fifth GLUTEN, and a little more than one-half oil. The oil, which is called "butter of cacao," is used in making soap, candies, pomades, and ointments. When the oil is pressed out of cocoa the flour which remains is made into an inferior article called "broma," which is not so rich as chocolate.

The chocolate sold in the stores is made of cocoa ground up with other substances, among which are sugar, molasses, honey, gum, starch, oatmeal, rice, flour, sago, and arrowroot, and spices and flavors, such as cinnamon, cloves, vanilla, etc. The mixture is made into a paste and poured into moulds to harden. Chocolate is largely used as a drink

and a food, and in making confectionery.

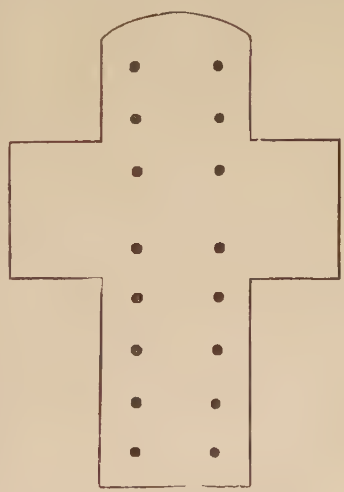
The word chocolate is from the Aztec *chocolatl*, which is made up of the words *choco*, cacao, and *latl*, water.

CHROMIUM, a metal, one of the ELEMENTS. It is very rare, of a shining steel-gray, as hard as CORUNDUM, and less easy to melt than platinum. It is found chiefly mixed with iron and oxygen, as chrome iron ore, and in a kind of earth called chrome-oçhre, in France and Siberia. Chromium makes with aluminum an ALLOY much like tin, harder to melt than nickel. Mixed with iron or steel it makes it finer and gives it greater hardness, toughness, and elasticity. Chrome steel is so hard that it is bored with difficulty by the best drills. The oxide (see OXYGEN) of chromium is largely used under the names of chrome green and ultramarine green for coloring glass and porcelain, as a paint in oil and water-colors, in printing, and in calico printing and dyeing. The greenish color of the emerald, verd-antique, marble, serpentine, and other minerals, as well as the red of the ruby comes from the oxide of chromium. The SALTS of chromium form with lead lead chromate, which makes a fine yellow, used in calico printing and painting, called chrome yellow, which, when mixed in certain ways, gives all the shades between lemon yellow and vermilion.

Chromium is named from the Greek *chroma*, color, on account of the beautiful colors of its compounds.

CHURCH, a building set apart for Christian worship. The early Christians, who did not wish to build their churches like the dark and gloomy heathen temples, into which only the priests and not the people went, made them somewhat like the Roman courts of justice named *basilicas*, from which some churches are still called basilicas. The basilica was a large oblong room in which the officer called a prætor held his court, and its form was well fitted for a place of worship in which the people as well as the priests took part. The upper end was raised above the main floor by a few steps, and here divine service was carried on. The altar was put in the middle of this, the prætor's seat became the bishop's throne, and the priests were seated on a circular bench at the end.

After a time changes were made; the raised part was built a little longer, and side entrances were put at the end of a kind of hall on



Plan of a Cross-shaped Church.

each side. This made the oblong basilica into the form of a cross, the shape in which most of the largest and finest churches are now built. The different parts of a church of this kind are shown in the picture. The long main part is usually divided into three parts by two rows of columns, which are marked by the rows of dots. The part between the columns in the lower part of the cross is called the nave (Latin *navis* a ship), because it is supposed to look something like a ship; and

the parts between the columns and walls on each side, which are usually narrower and lower than the nave, the aisles (Latin *ala*, a wing), because they are like the wings to a house. The upper limb of the cross, where the altar is, is the choir (Latin *chorus*, a band of singers), because the singers stood here, as they still do in some large churches. The choir sometimes has aisles, as shown in the picture. In small churches, where there are no aisles, the choir is usually called the chancel (Latin *cancelli*, a lattice), because it was formerly separated from the nave by a high lattice. The round end of the choir, which generally has an arched or rounded ceiling, often made of glass to admit light, is called the apse or apsis (Latin *absis*, an arch or dome). The two arms of the cross are called the transepts (Latin *trans*, across, and *septum*, an enclosure), because they cross the main body or nave of the church. The left transept is usually called the north transept and the right one the south transept, because the altar of the church is always supposed to be at the end toward the East, or Holy Land, where Christ was buried. The square between the transepts was generally lighted by a lantern or arched window, but afterward the tower of the church was often built above this.

In course of time other additions were made: a chapel was sometimes built beyond the apse, and other small chapels along the aisles; vestry rooms for the use of the priests and singers were built outside the choir, and other buildings were erected for various uses, until the once plain church grew into a collection of splendid structures, sometimes called a cathedral. A cathedral is properly the church where the bishop of a diocese officiates or performs the services, and is so called from the name of the bishop's seat or throne, which is called the *cathedra* (Latin *cathedra*, a chair or seat).

The word church is from the Anglo-Saxon *circ*, which is from the Greek *kuriakon*, the Lord's house, from *kurios*, the Lord.

CIDER, a drink made from the juice of apples. The apples should be ripe and mellow, because there is then more sugar in them and a better flavor than in green ones. They are first ground up into little pieces, and the pulp thus made, which is called the "must," is at once put into a cider press in layers folded in straw, which are called cheeses, and pressed. The juice runs into a tub, and, after being carefully strained, is put into barrels, where it is allowed to ferment or work (see BEER), after which it may be drawn off into other casks or put into bottles. These must be kept tight, or the cider will become sour and turn into VINEGAR. The Greeks and the Romans made cider.

The word cider is from the French *cidre*, which is from the Greek *sikera*, strong drink.

CIGAR, a small bundle of pieces of tobacco leaf wrapped up in an envelope made of a single piece of sound leaf. The piece for the wrapper is cut into a shape nearly like a quarter of orange-peel. It is laid flat on the table, and the edge of it is wet with a little gum water; the small pieces of leaf are then laid on it and rolled up in it, the gummed edge of the wrapper sticking it tight. One end is pointed by twisting it with the fingers, and the other end is cut off square.

The best cigars are made in Havana from tobacco raised in the island of Cuba; but many of those called Havanas are made in the United States. The cigars named "cheroots," which are cut off square at each end, are made in the East Indies, chiefly at Manilla in the Philippine Islands, whence they are often called Manillas.

A small cigar made of chopped up tobacco wrapped in a little piece of paper is called a cigarette (Span-

ish *cigarrito*, little cigar). These are smoked much by Cuban and Spanish ladies.

Cigar boxes are made of the wood of the Spanish CEDAR, which grows in the West Indies and Central America.

The word cigar is from the Spanish *cigarro*, the name given at first to a kind of tobacco raised in Cuba, but afterward to any tobacco made into a roll for smoking.

CINNABAR. See MERCURY.

CINNAMON, the inner bark of the young branches of a kind of laurel tree growing chiefly in Ceylon, but also in China and South America. In Ceylon, where the best cinnamon is made, the trees are raised from seed in plantations. The branches are cut when three to five years old and as large as a common cane, an outer bark scraped off, and the inner bark peeled off with a knife. The pieces are dried in the sun until they curl up into little rolls, when they are packed in bundles for market. The best cinnamon is taken from the tender shoots of the tree, and is almost as thin as paper. Cinnamon is used in medicine, cooking, perfumery, and confectionery. The oil of cinnamon is made from the leaves and fruit of the tree. What is called Chinese cinnamon is properly cassia; it is sometimes almost as good as true cinnamon, and is often sold for it.

The word cinnamon is from the Latin *cinnamomum*, Greek *kinnamomon*, cinnamon.

CISTERN, a tank for holding water. Cisterns differ from wells in that they do not get their water from natural sources, such as springs, but through channels made by the hand of man. In hot countries, where the supply of water is not regular, or where rain water is used, cisterns are necessary for storing up water for future use. They are also largely used for the supply of locomotive boilers at railroad stations. Cistern water used for drinking should always be filtered.

The word cistern is from the Latin *cisterna*, from *cista*, a box or chest.

CITRON, the fruit of an evergreen tree of the same family with the lemon and the orange, which grows in the south of Europe and in the East. The fruit is shaped like a lemon, but is larger and has a rougher skin. The juice is used for the same purposes as that of the lemon, thought it is not so sour. The peel preserved in sugar makes an excellent sweetmeat. From the outside of the peel and the leaves is made oil of citron, used by perfumers. Citric ACID is sometimes made from the pulp of the fruit, and extracts are made from the seeds and from the bark of the roots, and used for medicine.

The word citron is from the Latin *citrus*, Greek *kitron*, the citron tree.

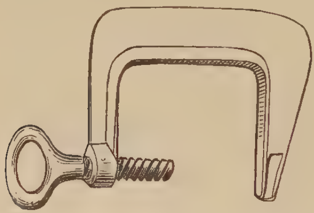
CLAM, the common name of several kinds of shell fish. The hard clam, called by the Indians *quahaug*, has a round and thick shell, and the soft clam, which is longer than it is broad, has a thin shell. Both kinds belong in salt water, and are largely used for food. They also make good bait for fishing; especially soft clams, which are salted in barrels for the cod and haddock fisheries. Soft clams are dug up along the seashore, where they lie in beds buried in soft mud or sandy gravel about a foot deep. They make little holes in the sand up to the surface, through which they reach with their long tubes toward the water when the tide is high, and take in food. They often spirt water up through these holes. Hard clams are found in soft mud nearer the surface. The Indians used to make their *wampum*, which passed among them for money, out of their shells.

The clam is an ANIMAL of the sub-kingdom of mollusks, and of the class of acephalous or headless MOLLUSKS.

The word clam is from the old

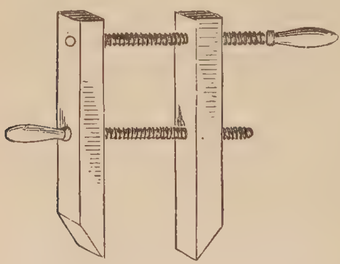
English *clamp*, meaning a thing which clasps together, like the two parts of the shell.

CLAMP, an instrument made to screw up, so as to hold work in place, much used by cabinet makers, joiners,



Iron Clamp.

and carriage makers. Clamps used by cabinet and carriage makers are made of iron, and have but one screw, as shown in the first picture. Carpenters' and joiners' clamps are usually of hard wood, and have two



Wooden Clamps.

screws, as in the second picture. These are called also hand-screws.

The word clamp is old English, and means a thing which clasps together.

CLAPBOARD, a narrow board commonly used for covering the sides of wooden buildings. Clapboards are usually of white pine, and are made much thinner on one edge than on the other, so that when nailed on to each other one can lap a little over the one next below it. This makes the covering of the building much tighter than if the boards were only set together one above the other, and keeps the rain from driving in. Clapboards are sawn out of solid logs, not by sawing them clear through, as in making common boards, but by sawing from the outside to the middle or heart of the log. They are thus made thicker on the outside than on the inside. They are afterward smoothed in a planing machine.

CLARET, a name given in Great Britain and the United States to all the red wines of the Bordelais, or country around Bordeaux. But this use of the word is unknown in France, those wines being called there either Bordeaux wines or by the names of the places on which they are grown. Common red wine is called *vin ordinaire* in France.

The word claret is from the French *clairet*, which means clear or clarified.

CLARINET or **CLARIONET,** a wind musical instrument, made of wood, used in orchestras and bands. It is usually of box, ebony, or cocoa, and has holes and keys for the fingers of the player. The tone is made by a thin piece of reed, which vibrates or trembles, when the player blows into the mouthpiece at the small end of the instrument. In fullness of tone, the clarinet is the most perfect of wind instruments, but as it cannot be played in every key in music, several of different kinds are used in an orchestra.

The word clarinet is from the French *clarinette*, which comes from the Latin *clarus*, clear, and the instrument is so named from its clear tone.

CLAY, a kind of earth made up of alumina (ALUMINUM oxide) and silica (see SILICON). But pure clay is seldom found, it being generally mixed with iron, lime, magnesia, and other things. It is of many colors, white, yellow, red, brown, and blue or slate color, and is usually found packed closely in solid beds. When mixed with water, clay is easily

made into a kind of putty or dough, and this is what gives it its great value in the arts. Among its most important uses are the making of bricks and of pottery and porcelain. Common clay, used for bricks, drain-tiles, and coarse pottery, is a mixture of clay and sand, with iron (iron oxide) enough in it to make it burn red. But some brick clay has so little iron in it that it burns yellow, like Milwaukee brick. Clay mixed with much LIME is called marl. Potter's clay has usually a little iron and lime in it, and generally burns dark red. It is used for coarse earthenware, such as flower pots, etc., and is the clay used by sculptors for modelling. PIPE clay, so called because clay pipes are made from it, is a purer kind of potter's clay. Fine stoneware is made of it. Fire clay is used for crucibles, stove-linings, and firebricks, because it is very hard to melt. It is usually found under coal beds. The finest kind of clay, used for making porcelain or china, is called kaolin, from Kao-ling, the name of a hill in China whence the clay for Chinese porcelain is taken. It is white or creamy-yellow, and is softer and more crumbly than other kinds of clay. Good kaolin is found in many parts of Europe, and in the United States, in Vermont, Delaware, South Carolina, Georgia, and other States. When taken from the bed, it looks much like MORTAR. It is first mixed with water and run through several vats, in which the coarse particles settle, and the milky liquid is then drawn into a shallow vat where the finer parts sink to the bottom. When clear the water is drawn off, and the kaolin is then dried, when it looks like fine white flour.

The word clay is from the Anglo-Saxon *clæg*, sticky earth.

CLOCK, a machine for measuring time. The ancients had no clocks like ours. They measured time at first by means of shadows, cast by the sun on an instrument called a sun-dial. The shape of a sun-dial can be seen in the first picture. which shows one fastened to the side of a wall. It is made of two parts, the dial-plane, on which the figures are, and the style, or little slanting rod on a peg in the middle, and fastened at the top of the dial-plane. The figures mark the hours of the day, like the figures on a clock-face, but they are arranged differently. The time is told by the shadow of the style which the sun casts on the dial-plane. In the picture the shadow lies half way between XII and I, so the time is about half past twelve. Of course, the dial would not show the time in

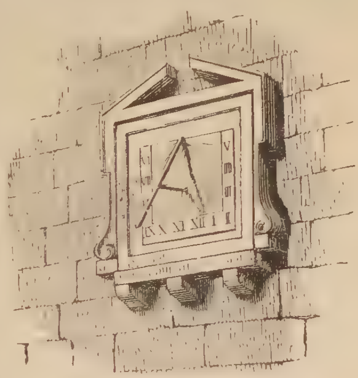


Fig. 1.—Sun-Dial.

a cloudy day. There were also moon-dials, to tell the time at night.

Afterward they used a kind of water clock called *clepsydra* (water stealer, from Greek *kleptein*, to steal, and *udor*, water), which was a vase filled with water, with a small opening in the bottom through which the water dripped drop by drop into a vessel beneath, which was thus said to steal the water. The side of the vase was divided into spaces by lines, and the height of the water in it marked the time. Instruments like our hour-glasses were also used, in which the time was measured by the running out of sand. King Alfred

the Great is said to have marked time by the gradual burning down of candles colored in rings. When wheel and weight clocks were first made is not known, but they were in use in the eleventh century. The pendulum (Latin *pendere*, to hang), or little weight which hangs below the works of the clock and swings backward and forward, was used first about 1657.

There are two kinds of clocks—spring clocks, in which the wheels

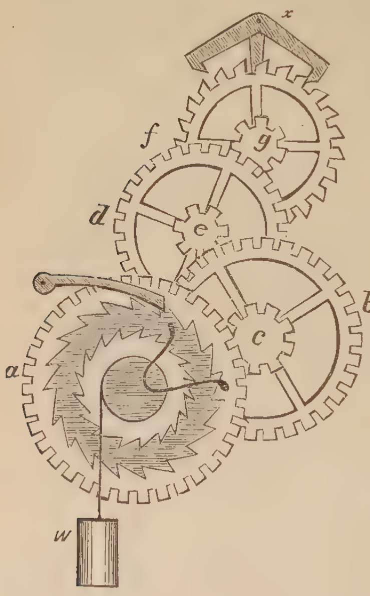


Fig. 2.—Wheels of a Clock.

are moved by power from the uncoiling of a coiled spring, and which will be told about in the article WATCH, and pendulum clocks, which are moved by the gradual falling of a weight, the falling being regulated by the swinging of a pendulum. When a pendulum is set swinging it makes each swing backward and forward in just the same time until it stops, no matter whether the swing is over a long or a short space. Its swing is over a longer space at first than toward the last when it is about to stop, but it goes faster, so that the time of the swing is always equal. This is called the "isochronism" (equal time, from Greek *isos*, equal, and *chronos*, time) of the pendulum.

The movement of a clock may be understood by looking at the picture (Fig. 2). The works are made up of what is called a "train" of wheels, in which the wheel that moves the one next to it is moved by the one that goes before it. In the common eight-day clock there are usually four cog wheels, or wheels with teeth, in the train, marked *a*, *b*, *d*, and *f*, in the picture. The axle or spindle on which a wheel turns is called an "arbor;" when the arbor is made with teeth or cogs around its edge, as in *c*, *e*, and *g*, it is called a "pinion." The cogs around the pinions are called "leaves," and those around the large wheels, "teeth." The string of the weight *w* is twined around the arbor of the wheel *a*. Now, the weight pulls so heavily downward that it would fall until it untwined all the string from the arbor if there was not something to stop it. This is prevented by making the teeth of the wheel *a* fit into the leaves of the pinion *c*, so that it can turn round only just as fast as *c* does. The pinion *c* being made fast to the second wheel *b* turns it, and *b* whose teeth fit into the leaves of the pinion *e*, causes the wheel *d* to turn the pinion *g*, which is fastened to the wheel *f*, called the "escapement wheel," and causes it to turn with it.

The "escapement" is one of the most important parts of a clock, because it connects the train of wheels with the pendulum and gives it the power which keeps it swinging. If it were not for the escapement the clock would run down with an even motion and would not keep good time; but the escapement and the pendulum change this even motion into another kind of motion, in

which the train of wheels moves in a series of little leaps or jerks. These jerks, which may be seen in the movement of the minute hand and heard in the ticking of the clock, are caused by the swing of the pendulum, and are therefore made in equal time, as told before. In the third picture (Fig. 3) *a* is the escapement wheel, *b* the regulator, marked *x* in Fig. 2, and *c* the pendulum rod. When the pendulum swings to the left, the pointed end of the regulator *d*, which is called a pallet, slips out from under the tooth *e* of the escapement wheel, which is moving from left to right, and at the same time the pallet *f* catches the tooth *o*. The pendulum then swings to the right, when the pallet *f* lets go of the tooth *o* and the pallet *d* catches another tooth next beyond the tooth *e*, and so on around the whole wheel. Thus, by the swinging of the pendulum, the escapement wheel, and through it all the other wheels which, as shown in the second picture, are connected with it and are kept going by the power of the falling weight, are made to turn regularly by little jerks, each of which is made in just the same time. The escapement wheel usually has thirty teeth, and as one of these teeth escapes from the pallets of the regulator at every full swing of the pendulum, that is, every swing backward and forward, which takes two seconds of time, it follows that the escapement wheel will go round once in twice thirty seconds or one minute. The teeth of the other wheels are so made that the wheel *b* (Fig. 2) will go round once in an hour, and it is therefore used to move the minute hand. The hour hand is moved by other wheels connected with a pinion on the other side of the pinion *c*, and which turns round once in twelve hours. The second picture shows the back of the wheels. The pendulum swings in front of them, and the hands and the clock face, on which the hours are marked, are in front of it.

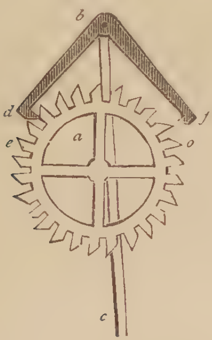


Fig. 3.—Escapement of a Clock.

Town clocks and church clocks are made to move by trains of wheels in much the same way, but the wheels are very large and strong, and the weights and pendulums very heavy. It is very hard work to wind up a church clock, and it needs a strong man to do it. In winding up the clock in the tower of Trinity Church, New York, the crank or handle has to be turned round 850 times. Many wonderful clocks have been made, in some of which the machinery moved figures of men and animals in a very curious way. At Heidelberg, in Germany, was formerly a town clock, which, whenever it struck the hour, caused the figure of an old man to pull off his hat, while a cock crowed and clapped his wings, and soldiers fought with one another. This clock was destroyed by the French when they burned Heidelberg in 1693. There is another curious clock at Lyons, in France. When the time comes for striking the hour, two horsemen meet and beat the time on each other. A door then opens and the Virgin Mary comes out with Christ in her arms; and while two trumpeters blow on their trumpets, the Magi, or wise men of the East, march by with their followers in procession,

and present gifts. But the most wonderful clock is that in the Strasburg cathedral, which shows the proper motions of the sun and all the planets, and marks not only the hours and minutes, but the years and months, and all the feast days and other important days of the year. There are also many figures which are moved by its machinery. In the upper part of the clock are the statues of four old men, who strike the quarter-hours. Death comes out at each quarter to strike, but Christ, with a spear in his hand, drives him back; but when the last quarter comes Christ goes inside and Death comes out and strikes the hour with a bone in his hand, and then the chimes sound.

The word clock is from the Anglo-Saxon *clucge*, in French *cloche*, German *glocke*, meaning a bell.

CLOTH. If you look closely at a piece of plain cotton cloth you will see that it is made up of two sets of threads, one of which runs lengthwise, and the other across the cloth. Those which run lengthwise, or the long threads, are called the "warp," and the short ones which cross them the "woof" or "weft." Every kind of cloth has a warp and a weft; but they are woven together in many different ways.

To begin to make a piece of cloth the weaver first stretches out all the warp threads on the LOOM side by side, arranging them over the yarn beam at one end and the cloth beam at the other, so that as they unwind from the first they are wound up on the second. The fineness or coarseness of the cloth depends on the size of the threads and the distance between them, and the width of the cloth on the number of the threads. The kind of cloth depends on the way in which the weft threads are woven into the warp. In plain cloth, like common cotton or linen, the weft is passed over the first warp thread, under the second, over the third, under the fourth, and so on across the piece. In twilled cloth, like satin, tweed, cassimere, and bombazine, the weft does not pass over and under each alternate thread, but over two threads and under one, over three and under one, or over four or five and under one, etc. In some kinds of satin even fifteen threads are passed over at once. All twilled cloths have a kind of stripe running diagonally or corner-wise across them, which is made by this way of weaving in the weft threads. In pile cloths, or those which have a nap or surface of threads standing up, like VELVET, velveteen, and Wilton and velvet CARPETS, other threads are woven in with the weft so as to make loops over wires. These loops are cut and the ends are then sheared evenly, leaving the surface a soft, smooth, beautiful nap. Figured cloths, like damask and brocade, are made by weaving patterns in among the warp and the weft, either by the same or by other threads.

Figured cloths are made by weaving with different colored yarns. In mixed goods the warp is of one color and the weft of another; in striped cloths the warp threads are of two or more different colors; and in checked patterns, both the warp and the weft are of two colors, one set of stripes crossing another.

The word cloth is from the Anglo-Saxon *cloth*, German *kleid*, a garment.

CLOUDS, bodies of watery vapor seen high in the air. Dampness in the AIR remains invisible—that is, unseen—until the air becomes saturated with it, or so filled with it that it cannot hold any more, when it falls as DEW or RAIN, or turns to FOG and clouds. The amount of dampness which the air can hold depends upon the heat. When the air is warm the watery vapor is expanded, or made thin, and is carried off into the higher parts of the air; but when it is cool it is condensed, or made thick and heavy, and then

we can see it. When the air has not too much dampness for the amount of heat in it, it is clear, and we can see the bright blue sky; when it has a little too much, it is filled with fleecy clouds; and when it has altogether too much, the clouds become dark and heavy and at last fall as rain.

There are four kinds of clouds, called cirrus, cumulus, stratus, and nimbus. Cirrus clouds (Latin *cirrus*, a lock of hair) are of feathery form, like locks or curls of hair, spread out all over the sky or arranged in narrow stripes. They are the lightest and highest of all the clouds, being often seen in summer far above other clouds. When they change much in a few hours they denote windy weather. Sailors call them mares' tails or cats' tails. Cumulus clouds (Latin *cumulus*, a heap or pile) are the great piles of white-topped clouds seen in summer days. As the sun becomes warmer the moisture in these clouds becomes thinner and lighter and they rise higher in the air; but toward nightfall they generally grow smaller and vanish with the sunset. If they increase and grow darker in the evening, rain usually follows. Stratus clouds (Latin *stratus*, spread out) are those which are stretched out in sheets, layers, or bands. They lie much nearer the earth than other clouds, and often creep along valleys in the shape of mist or fog, going away with the coming of day. These clouds are seen mostly at night and in winter. Nimbus clouds (Latin *nimbus*, a rain-cloud) are the proper rain clouds. They are heavy and threatening, black or gray, and with ragged edges. Snow and hail, as well as rain, sometimes fall from nimbus clouds, which are seen in their most perfect form during thunder storms.

The form and height of clouds vary with the amount of dampness in the air, the height and course of winds, the height of land, the extent of land and sea, the climate, the season, etc. From clouds comes the rain which gives moisture to plants, and water to springs, rivers, and lakes. All kinds of clouds may sometimes be seen in one day, and the various kinds are often mingled together.

The word cloud comes from the Anglo-Saxon *clûd*, a hill, clouds often looking like hills.

CLOVES, the dried flower buds of a kind of myrtle tree, which grew first in the Molucca Islands, in the Indian Archipelago. The tree, which grows four or five times as high as a man, is an evergreen and very beautiful. It has a straight trunk, with smooth bark, which branches about half way up; the branches grow smaller toward the top, so that, when covered with leaves, they form a pyramid of green. The flower buds are picked before they begin to open, and dried in the shade. The little ball at the end of the clove is the flower, folded up.

Cloves are used as a seasoning in cookery. The oil of cloves is largely used in making perfumery, and is sometimes given by physicians as a medicine. If cloves be chewed before taking bad-tasting medicines, such as castor oil and cod-liver oil, the medicines will not taste bad.

Cloves are now raised in Sumatra, Zanzibar, Mauritius, the West Indies and Brazil, but the best are brought from the Moluccas, where the tree grows better than anywhere else.

The word cloves comes from the Latin word *clavus*, a nail, and the spice is so called because it looks like little nails. The Dutch call it *kruydnagel*, nail-spice.

COAL. There was a time in the early history of the earth when all parts of the surface had a very hot climate; even the Arctic regions, where now is frost and ice all the year round, being much like the middle of Africa. There were then no changes in heat and cold, but the

same heat existed in all parts, and the same kinds of plants grew all over the globe. These plants were of immense size and grew so thickly that they made a dense forest everywhere. There were then no animals on the land, and only a few fishes and MOLLUSKS in the sea. Most of the plants were of the lower kinds, such as LICHENS, fungi (see FUNGUS), MOSSES, SEAWEEDS, FERNS, and cone-bearing trees, and there were no flowers and no fruits fit for eating. For thousands of years these great forests of plants grew up and died, and were followed by other plants, until the swamps and low lands became filled up with thick closely packed beds of vegetable matter.

At this time the crust of the earth was not very strong, and it might happen that parts of it would sink so that some of these great beds of vegetable matter were brought under water. Then the matter would partly rot and become packed so closely that it would turn into PEAT. In time heat and pressure would cause a second change, and the peat would turn into a kind of brown coal called lignite. A third change would turn this brown coal into real coal. Thus coal is made up of the remains of trees and plants which grew on the earth before man or any other animal had appeared. Changed by pressure, heat, and dampness, this mass of vegetable matter has become a kind of CARBON, mixed up with BITUMEN or the tarry substances which are always made by the slow decay of such matter.

Kinds of Coal. Coal is thus made up of carbon mixed with bitumen, and the kind of coal depends on the amount of bitumen in it. It is commonly divided into three classes: anthracite, hard, or stone coal, sometimes called glance coal on account of its shine, which has the least bitumen in it; bituminous coal, which has in it much more bitumen than anthracite; and cannel coal, which has in it the most bitumen of all. Of these coals, the anthracite is harder and closer-grained and has less bitumen in it than the others because it has had more pressure and more heat. If it had had still greater heat and pressure, it would have undergone another change and become plumbago or BLACK LEAD. The best anthracite coal is found in the United States, where it is chiefly used. A little less than one-half of the coal mined here is anthracite. Most of it comes from Pennsylvania.

Coal Measures. In the article ROCKS is told that coal is usually found in seams or layers, with rocks on top of it. The seams vary from one inch to thirty feet in thickness, and the rocks between them are generally sandstone and a slaty kind of rock called shale. Taken altogether these layers or seams are called "coal measures"; and the coal measures together with the rocks under them, which are always limestone and old red sandstone, form what is called the "coal formation," or the "carboniferous system."

The layers of the coal measures are not always straight and level, but are often slanting, or bent up at the ends, or hollow like a basin. When they bend up so that the coal seam comes to the surface of the ground, it is called an "outcrop." Sometimes breaks are found in the seams; these are called "faults" or "dykes" and are often a great trouble to the miner, who does not know which way to dig to find the coal again. When an outcrop is found, it is easy to mine the coal by digging into it a kind of tunnel, called an "adit" or "drift," up which it is brought in cars; but sometimes very deep pits must be dug to reach it. These pits, which are called "shafts," are sometimes more than a quarter of a mile deep, and pass through many seams. As each seam is reached a side passage is cut into it, and from each side of this other passages are cut.

There are many such passages through each seam, all connecting with each other, so that the coal seam is cut up into a kind of town with streets and lanes. As the coal is dug away the roof is propped up with strong posts and beams. The coal is sometimes dug out with picks and other tools, sometimes blasted with gunpowder, and sometimes cut into blocks by coal-cutting machines. It is hoisted from the mines through the shaft in iron boxes or cages by means of a rope or chain passing over a wheel at the top, which is worked by a steam engine. But in some of the largest mines tunnels lead from the surface down a gradual slant into the side of the hill, and the coal is brought up through them in carts, drawn sometimes by mules and sometimes by steam. The coal is then sorted into different sizes by dumping it onto wire screens or sieves, when it is ready for shipment.

Uses of Coal. Coal is one of the most valuable of the things got out of the earth, not only on account of its use as a fuel for warming houses, but for the making of steam, the smelting and manufacture of metals, and other uses in the arts. From it we get the GAS which we use for lights, paraffine oil, and the many other useful products, including the beautiful aniline colors, which are made from coal tar.

Coal Fields. Coal is found in almost all parts of the world, but the largest coal fields are in the United States, where coal was mined in 1889 in thirty-one States and Territories. There are four principal coal fields; the Appalachian or eastern, extending from New York to Alabama; the Illinois or central, including western Indiana and Kentucky; the Michigan or northern; and the western, which lies in Iowa, Missouri, Nebraska, Kansas, Arkansas, Texas, and Indian Territory. Coal has been mined also in Washington, Oregon. and California. Pennsylvania yielded nearly three-fifths of the entire output; Illinois came second, and then, in order, Ohio, West Virginia, Iowa, and Alabama. In Europe, Russia has the largest coal fields and Great Britain the next largest, but Great Britain mines more than half of all the coal dug in the world.

History. Coal was used in Britain by the Romans for smelting iron and and perhaps for warming, and some think they learned its use from the Britons, for it is not known that they burned it in any other of the countries belonging to them. About the end of the thirteenth century it was sent by water to London from Newcastle for use by smiths and other tradespeople, because wood had become scarce; but people thought it poisoned the air, and in 1306 the king ordered its use stopped. But those who learned to burn it had found out its value and continued to use it, and a law was passed making its use punishable with death, and it is said that a man was actually excuted in the reign of Edward I. for using it. Even as late as the close of the sixteenth century ladies thought their complexions would be injured by going into a room where coal was burning, and some people would not eat meat roasted at a coal fire. These notions were given up in England about the beginning of the seventeenth century, but in France the prejudice against coal continued down to this century.

The way to burn anthracite coal in furnaces was not found out, though some had been burned in grates, until 1812, when Josiah White and Erskine Hazard, who had a factory for making wire at the falls of Schuylkill, Pennsylvania, first learned how to use it. After spending an entire night in a vain attempt to light some in a furnace, which had a poor draft, the workmen shut the furnace door and left the coal to take care of itself. One of them, who had left his jacket in the mill, went back for it in about half an hour and was surprised to see the furnace door red hot. The

other workmen were called back and on opening the furnace the mass of coal was found in a white heat. The secret of kindling it had been discovered. In 1814 a few boat loads were brought down the Delaware River, but it could not be sold, for people said the black stones would not burn. In 1817 White and Hazard got a lease of coal lands in the Lehigh Valley for an ear of corn a year, so little did people know of its value. In 1820 they sent 365 tons to market, that being enough to supply all those who wanted it. In 1827 the railroad from the mines to Mauch Chunk was built, the first coal road in this country, and, excepting one or two in England, one of the first built anywhere. It was a gravity road—that is, the cars ran down by their own weight or gravity. They were hauled back by mules, who rode down again with the coal train in a car made for them. After they had ridden once they could never be got to walk down again. Immense steam engines long ago took the place of the mules in hauling up the coal cars.

The word coal is from the Anglo-Saxon *col*. It was spelled "cole" until about 1650. In England coal broken up for use is called "coals." The word anthracite is from the Greek *anthrax*, stone coal.

COBALT, a METAL, one of the ELEMENTS. When pure, cobalt is a hard white metal, which does not change at common heat, and which may easily be hammered when red hot. It is never found by itself, but generally united with NICKEL, ARSENIC, and SULPHUR. Cobalt is much used in the arts, chiefly to make fine colors. Smalt or azure blue is made by adding oxide of cobalt to melted glass, which, after cooling, is of a beautiful blue, and then grinding it to powder. Smalt is used for coloring pottery and porcelain, glass, enamels, tiles, and paper-hangings. Green, blue, and yellow paints are also made from cobalt. The word cobalt is from the German *kobalt*, from *kobold*, Greek *kobalos*, an elf or sprite, because miners looking for copper and silver used to think that the ores of cobalt, which they did not then know about, were put in their way by elves and sprites to deceive them.

COCA, the dried leaf of a shrub that grows wild in the mountainous parts of Peru and Bolivia. The leaves, which resemble tea in size, shape, and smell, are mixed with quicklime and chewed by the natives to give them strength for long journeys, even enabling them to go without food. It is said that the Peruvian Indian, with a small supply of it in his pouch, will travel day after day without fatigue. If used too freely it intoxicates like opium, and the appetite for it grows until death releases the victim.

Cocaine, which is made from its leaves, is a bitter, white, crystalline, substance, used by surgeons for producing insensibility to pain. When applied to the part to be operated upon it numbs it, so that the patient feels no pain. It is much used in operations on the eye.

The word coca is Spanish, and is made from the Indian name of the plant.

COCHINEAL, a dye stuff made from the dried bodies of insects. The cochineal insect is very small, there being about seventy thousand of them in a single pound of dried cochineal. The male is deep red and has light brown wings; the female has no wings and is deep brown. In the picture the insect with wings is the male; the two without wings show the female, the smaller one being the natural size, and the larger one the magnified. The insects feed on CACTUS plants, particularly on one called in Mexico *nopal*, which is something like the prickly pear. There are large plantations of nopal in Mexico, where the cochineal bugs are tended with the greatest care. Each female produces more than a

thousand eggs, and the young insects spread, as soon as they are hatched, all over the leaves of the plants, where they feed and swell up so that they look like little knobs. They are now gathered by being scraped off with a knife or brush, killed by boiling water or heat, and dried. There are but few males, and only the females are good for dyeing. When dried the insects look like little shrivelled grains.

Beautiful scarlet and crimson dyes are made from cochineal, and also the artist's colors called carmine and lake. It is used chiefly for dyeing silks and artificial flowers, and for making red INK and rouge. Since the discovery of aniline dyes, made from coal tar, cochineal has not been used as much as it once was

Cochineal Insects.
Male and Wingless Female—Natural Size and Enlarged.

and the cultivation of the insects is gradually dying out.

The cochineal insect belongs to the order *hemiptera*, or half-winged INSECTS.

The word cochineal is from the Spanish *cochinilla*, from the Latin *coccum*, a berry, the insect being once thought to be the seed of a plant.

COCKROACH. There are several kinds of cockroaches; those which have always lived in the United States are found in the woods usually under stones, rotten logs, and fallen leaves, and seldom go into houses; those which run around houses were brought from Asia in ships' cargoes. Cockroaches will eat both animal and vegetable food, and destroy even leather and clothing. They come out of their holes in the

Croton Bug.
Male. Female.

night in search of food, sometimes in swarms, and often spoil by their bad smell what they do not eat; but they are also very useful, for they eat many bedbugs, of which they are very fond. They may be driven away by BORAX, which they do not like, or may be poisoned by a mixture of red lead with Indian meal and molasses. A small kind of cockroach, abundant in houses in New York and Boston, are called Croton bugs. They are shown in the picture, the smaller one on the left being the male and the other the female.

The cockroach belongs to the order *orthoptera*, or straight-winged insects.

The word cockroach is from the Portuguese *cacaroucha*, a beetle.

COCOANUT, the fruit of the cocoanut palm tree. The tree, which is found chiefly in the islands of the Pacific and Indian oceans, grows about two feet thick and sometimes a hundred feet high, or twice as high as a four-story house. It has no branches, but at the top is a crown of fifteen or twenty feather-like leaves, each twelve to twenty feet long, under which the nuts hang in bunches. A tree in full bearing will ripen eighty to a hundred cocoanuts every year. Each nut is enclosed in a thick soft husk. The shell of

the nut is very hard when ripe. When it is green it is lined with a soft ALBUMEN like jelly, within which are from one to two pints of a clear liquid. When the nut ripens the albumen becomes hard and the liquid very sweet and sickish to the taste.

The cocoanut is one of the most valuable trees in the world, nearly every part of it being useful to man. The young roots are chewed by the natives, and also woven into baskets. The trunk of the tree furnishes canoes, posts and rafters for houses, and fences; the young green shoots, which have a soft pith, are made into

Cocoanut Tree.

water pipes, and the old wood, which becomes very hard and takes a beautiful polish, and which is called porcupine wood, is used in cabinet work. The young leaves are cooked and eaten like cabbage; the old leaves are made into cloth, hats and bonnets, baskets, lanterns, fans, bedding, thatch for houses, fish nets, writing paper, and many other things; and the ribs of the leaves make paddles for boats, spears and arrows, brooms, combs, and torches. When burned, the leaves and wood furnish potash for soap. From the flowers is made a drink called "toddy," which when fermented (see BEER) is called "palm wine." Good vinegar also is made from it by more fermentation, and a fair sugar called "jaggery" is made by boiling down the fresh toddy. Jaggery mixed with lime makes a strong cement.

The husk of the nut furnishes the fibre called "coir," an excellent material for cordage, matting, mattresses, brushes, and brooms. Small cord made of this fibre is called "sinnet," and is used by the natives to tie pieces of wood together where we would use nails. The hard shell of the nuts takes a beautiful polish, and is made into ladles, cups, etc.; when burnt it makes lampback, and its charcoal is used for cleaning the teeth.

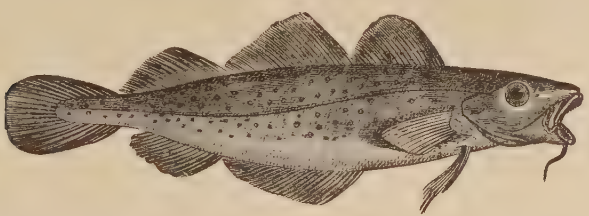
When the nuts are green the pulp is good for eating and the liquid makes a refreshing drink; the pulp is also eaten after it becomes hard, and is much used in cookery and in making confectionery. The old nuts produce cocoanut oil, used for cooking, for annointing the body, and for burning in lamps. It is sent to foreign countries, where it is made into stearine candles, toilet soap, marine soap (a kind of soap which will make a lather with salt water), and various ointments and hair dressings.

A new and important use for cocoanut fibre in ship building has been recently discovered in France. In firing at a target made of moistened cocoanut husks the marksmen found that every shot hole closed up at once, leaving not even a scar. This led to some experiments which proved that a ship built with a lining made of cocoanut fibre would be unsinkable from shot, because the shot hole would close up before water could get in. The Detroit and others of the new United States naval vessels have had their sides fitted with such a belt of cellulose.

The word cocoanut is made up of the Portuguese *coco*, Greek *kouki*, the cocoa tree, and the English nut, Latin *nux*.

COD, a kind of fish. There are several kinds, the principal American ones being the American cod, found on the coast from the Hudson to the St. Lawrence river, the Bank cod, from the coast of Maine to Labrador, and the tom cod, from New York to New Brunswick. The first two kinds sometimes weigh ninety to a hundred pounds each, or as much as a boy twelve years old. The kind shown in the picture is the Bank cod, which is the most common.

The principal cod fishery is on the Grand Bank of Newfoundland, where English, French, and American fishing vessels go every year; but there are also very important fisheries off the coasts of Norway, Iceland, Holland, Scotland, and the Pacific coast of the United States. The Grand Bank of Newfoundland is the flat top of a kind of mountain which rises up out of the deep sea so as to make a vast rocky shoal, where the water is much shallower than in other places, and here the codfish find the best feeding and breeding places. There are also other banks along the coast, some west and some east of the Grand Bank, which the fish seem to like equally well. Cod are caught on these banks all the year round. Many are taken in nets, but the vessels from the United States fish mostly with "trawls" and "hand lines." The trawl is a long line anchored at each end, with several hundred fish hooks fastened to it a little way apart, and so marked with buoys that it can easily be found and hauled up. The hooks are baited with pieces of herring, mackerel, or squid, a kind of MOLLUSK, but codfish are so greedy that they will bite at almost anything. A fish is often found on every one of the hooks when a trawl line is taken up. Those who fish with hand lines, or single lines with two or three hooks on each, use salted clams for bait at first, but afterward catch squid and use them. While fishing, the vessel lies at anchor on the bank, and the fishermen go off from her in "dories," a kind of flat-bottomed boat. When the dories are filled they go back to the vessel, and the fish are dressed and salted away in the hold. The dressing is done very fast. A man called the "throater" cuts the fish's throat and rips it open, and passes it to the "header," who cuts off the head and takes out the entrails; the "splitter" then splits it wide open and takes out a part of the backbone, and the "salter" piles the fish up and salts it. When the vessel arrives home the fish are taken out of the hold, washed, and dried on platforms or under sheds on the shore. The sun and the wind soon dry them, and give them the white, bleached look which salt codfish usually have. Great numbers of cod are also cured on the shore at Newfoundland, mostly by British and Canadian fisherman. They are dried in long sheds, or hung up on frames, as shown in the picture.



Cod.

In cleaning codfish, the livers and

the sounds and tongues are saved. The livers are put into oak tanks and pressed to get out the oil, which is much used as a medicine for consumption, scrofula, and other diseases. The first oil pressed out, which is the kind used in medicine, is clear and light-colored; but the livers soon begin to putrefy or spoil, and the second run of oil is pale brown; finally the livers are boiled in water, and a dark brown oil is got from them. The tongues of the fish and the sounds, or air-bladders, are salted in barrels. They are esteemed a delicacy; and ISINGLASS is sometimes made from the sounds. In some places fish guano or manure is made from the heads and entrails of the fish, but they are usually thrown overboard.

The Norwegian fisheries, especially those at the Loffoden Isles, are carried on chiefly for the making of cod-liver oil. As soon as the fish is hoisted into the boat, its head is cut off and its liver and roe taken out, the last being used as bait for sardines. A special boat, fitted as a manufactory, follows the fishing boats, and collects the livers, which are immediately put into basins heated by steam to extract the oil. The oil is afterward refined and purified before being sent to market. The body of the fish is dried on the rocks to make "klipfish," which is sold to Spain and the West Indies, and the head, entrails, and other waste parts are made into fish guano,

Drying Codfish at Newfoundland.

COFFEE. The coffee berry is the seed of a tree which grows wild in Abyssinia, Guinea, and some other parts of Africa. This tree is sometimes four or five times as high as a man, but it is usually kept down by cutting to a height of about five feet, or a little lower than a man, so that the berries can be easily picked. The plant is raised from the seed in nurseries, and when one year old is set out in the plantations. It begins to bear when three years old, and will yield for more than twenty years. The leaves are evergreen and never change, and the tree blossoms and bears fruit almost all the time, flowers and ripe fruit being seen on the tree at the same time; but the seeds are gathered usually only twice or three times a year.

The fruit looks like a cherry, and is red when ripe, but finally turns

dark purple. It is sweet and good to eat. Each one contains two seeds, or coffee beans, which lie with their flat sides to each other and are held together by a tough skin which covers them. When ripe the fruit is gathered and dried, and the outer part is easily removed by hand or by being rolled under wooden rollers. The seeds are then dried again, the tough skin around them is broken by other rollers, and after the chaff and light husks have been cleaned from them the coffee beans are ready for market.

Coffee Plant and Berries.

Coffee is said to have been used in Persia about a thousand years ago, but it has been known in Europe only about three hundred years. The first coffee house in London was opened in 1652, or thirty years after the Pilgrims came to New England. Coffee was first brought to America about a hundred and fifty years ago (1720 to 1725) by Captain de Clieu of the French navy. He thought that it would grow in America as well as in the East Indies, where the Dutch were then raising it, so when he was about to sail for Martinique, in the West Indies, he got three coffee plants from the *Jardin des Plantes* (Garden of Plants) in Paris. The voyage was long and stormy, and the supply of water nearly gave out. Captain de Clieu, who, like all others on the ship, had but a very little each day to drink, divided his with his coffee plants, and, though two died, one arrived safe at Martinique. It was at once planted and great care taken of it, and from it have come all the coffee plants growing in America.

The principal countries where coffee is raised are Brazil, Java, Sumatra, India, Ceylon, Arabia, Abyssinia, Central America, the West Indies, Venezuela, the United States of Colombia, and Peru. The best and most fragrant coffee is Mocha, which is raised in the southwest part of Arabia: but most of the coffee sold under the name of Mocha comes from India, Africa, and Brazil. Java coffee, considered the next best, comes from the islands of Java and Sumatra and other parts of the East Indies. Much Brazilian coffee is sold as Java. Indeed, more than half the coffee used in the world is raised in Brazil. Maracaibo coffee comes from Venezuela and countries near there. Liberian coffee is the berry of a tree of stronger growth than common coffee, that grows wild in Liberia, Angola, and other parts of western Africa. The berries are larger than other kinds.

The word coffee is from the Turkish *kehveh*, and the plant is supposed to have got its name from Kaffa, a part of Abyssinia, where it grows wild.

COIN, a piece of metal stamped with a DIE and used as money. Coins are always made by the governments of the countries where they are issued, in order that the quality, weight, and size of each kind may be exactly alike. Their manufacture requires the greatest care and skill, and very fine and costly machinery, Almost all coins are made of an ALLOY or mixture of metals. In the United States gold and silver are alloyed with copper, because when pure they are too soft to wear well. The metals are first melted together and run into ingots, or small bars about a foot long, an inch or two wide, and a half inch thick. These

ingots are then rolled out into ribbons of the right thickness for the coin to be made, by passing them several times between heavy steel rollers, driven by a steam engine. The ribbons are next drawn through a steel gauge to straighten them, and to make them of exactly the same thickness, when they are ready for the cutting press. In this machine a punch, which works up and down into a round hole in a steel plate, cuts the ribbons up into round pieces called blanks or planchets, of the proper size for making the coins. The planchets are now passed through the milling machine, by which the edge of each one is crowded up into a rim or border. This is a little higher than the figures on the face of the coin, and protects them from being rubbed as much as they would be if it were perfectly flat.

The planchets are now cleaned by putting them into weak hot sulphuric acid, washing them in water, and drying them in sawdust, and are then ready for stamping or coining. The coining press is a very powerful machine, worked by a steam engine, which stamps out a coin with a single blow, by forcing the upper DIE down on to the lower or counter die. The counter die is fastened firmly on a strong bed plate, and a kind of ring, called the collar, is put over it. The collar, which comes up just far enough above the face of the counter die to hold the coin when the upper die is pressed down, has its inner side notched all round. The planchets are put by hand into a kind of hopper or tube in front of the machine, from which they are taken by little finger-like pieces of steel called feeders, and carried one by one into the collar. As each piece comes in, the upper die is forced down on it and crowds it on to the counter die, stamping it at once on both sides and forcing its edges into the notches around the collar. These notches make what is commonly called the milling on the edge of the coin, which is intended to prevent the clipping or filing down of the edges, because such filing would show on the milling. In old times, when coins were made with smooth edges, this was much done by dishonest persons, who got a good deal of gold and silver by clipping a large number of coins.

As soon as the coin is stamped the action of the machine raises the upper die, and the feeders, coming up with a second planchet, push the finished piece out. The coins are carefully looked over to see that all are perfect, and they are then counted and put into bags.

The coins of the United States are made at the Mint in Philadelphia, and at the branch mints in New Orleans, San Francisco, Carson City, and Denver. Those coined in Philadelphia have no mint mark on them, but those coined in New Orleans have an O on the reverse below the eagle, those coined at San Francisco an S, those coined at Carson City, C C, and those coined at Denver a D.

The word coin is from the French *coin*, which is from the Latin *cuneus*, a wedge or die with which money is stamped. It is probable that the first stamping was done with a wedge.

COKE. There are two kinds of coke—gas coke, which is told about in the article GAS, and coke which is made in heaps or ovens. Coke is charred bituminous coal, just as CHARCOAL is charred wood; and it consists only of CARBON mixed with some earthy matters. When it is charred in heaps the coal is piled up in a stack, which is sometimes round and sometimes oblong, with openings left for the air. Fire is then set to it, and it is allowed to burn until smoke no longer rises from it. The air holes are then stopped by covering the heap with coal dust, and the coke is left to cool. During the burning, smoke, watery vapor, coal gas, and coal tar are given off, and the

remainder is coke. A better way to make coke is to char the coal in great ovens built of firebrick for the purpose. The coal is put in at the top, and a little air let in at openings in the front. As soon as the smoky vapor ceases to pass off, the oven is closed tight and allowed to cool for a day. The coke is then raked out, and if still afire the fire is put out with water.

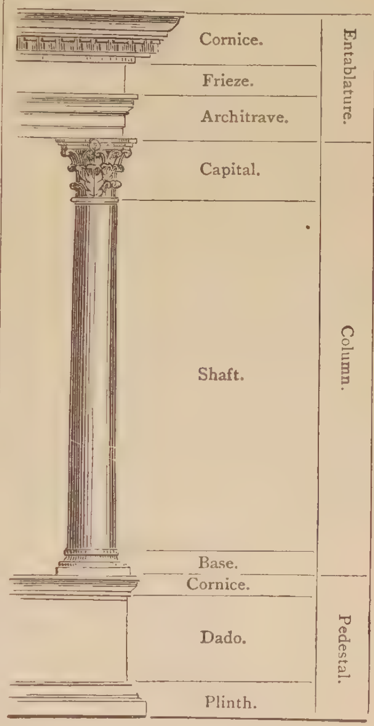
Coke is lighter than coal, and porous, or full of little holes. When used as a fuel it makes a great and steady heat without smoke, and leaves but little ashes. It is largely used in Europe, where anthracite coal is lacking, in furnaces for smelting metals and in furnaces where smoke is not wanted. In England it is burned in locomotives on most of the railways.

The word coke is from the local English *cokes* or *coaks*, cinders.

COLOGNE, or COLOGNE WATER, alcohol perfumed with essential OILS. It is made of many different things and in several ways. The best cologne is said to be a mixture of balm and mint, petals of roses and violets, lavender flowers, absinthe, sage, thyme, orange flowers, nutmeg, mace, cloves, cinnamon, camphor, and other things distilled with ALCOHOL. Some is made without distillation, but it is not so good. Most of the cologne sold in the shops is a cheap imitation of real cologne.

Cologne is so named because it was first made in Cologne, on the Rhine. The French call it *eau de Cologne*, Cologne water.

COLUMN, a pillar or post for holding up a roof, gallery, etc. The parts of a column may be seen in the picture, which shows a column, its pedestal or the part on which it stands, and the entablature or part which it holds up. The pedestal is made up of the plinth, the dado or die, and the cornice, and the entablature of the architrave, the frieze, and the cornice. The column itself is in three parts—the base or lowest part, the shaft or middle part, and the capital or top part. The flat cap of the capital, on which the entablature rests, is called the abacus. The Greeks had three kinds of columns, the Doric, the Ionic, and the Corinthian, all of which, excepting the Doric, had these three parts; the Doric had no base, the shaft standing right on the pedestal.



Corinthian Column, with Pedestal and Entablature.

These three columns make the three styles or orders in Greek architecture, which are named after them the Doric, the Ionic, and the Corinthian orders. The chief differences between them are in the capitals, The Doric capital, which was the first made, being very plain, the

Ionic capital, which came next, being more ornamented, and the Corinthian capital the most highly ornamented of all. The idea of the Corinthian capital is said to have been got from a plant called acanthus, which has pointed prickly leaves. The story is that a young girl of Corinth died, and her nurse collected the articles which she had loved, put them in a basket on her grave,

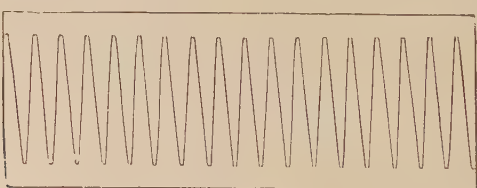
Doric Capital. Ionic Capital.

and laid a tile on top of it. By chance the basket was placed on the roots of an acanthus plant, and this, sprouting in the spring partly, covered the basket with its leaves, some of which, reaching the tile, turned downward. An architect named Callimachus, who happened to see it, was struck by its beauty, and thought it would make a fine capital for a column; and by changing it a little he made the Corinthian column, which has got its name from Corinth. But unfortunately for this story told by Vitruvius, the Roman writer, there is nothing to show, either from ruins or records, that the Corinthian column was ever known in Corinth, where the chief buildings were probably Doric. Besides, the temple of Apollo at Miletus in Ionia, built a century before the time of Callimachus, was decorated with Corinthian columns; and the Corinthian capital was used still earlier in Assyria (See ARCHITECTURE, Assyrian).

The shafts of all the Greek columns were fluted—that is, they were carved all around, from the base to the capital, in little hollow channels called "flutes."

In later times were added to two other styles, the Tuscan, in which the column was some like the Doric, but had a base, and the Composite, which was a mixture of the Ionic and the Corinthian. In Gothic architecture there are many beautiful kinds of columns, often much decorated with leaves and flowers.

In former times fine columns were always made of solid stone, generally of marble or granite, but now



Combs Cut with a Punch.

many columns are made of cast iron. These are made to look on the outside like a stone column, but they are always cast hollow, because if solid they would be too heavy; and a certain weight of metal cast in a hollow column is stronger than the same weight cast solid.

The word column is from the Latin *columna*, a column or pillar.

COMB. Combs for dressing the hair have been in use from the most ancient times. The combs of the Egyptains, many of which have been found in tombs, were of wood, and usually had coarse teeth on one side and fine on the other. The combs of the Greeks and Romans were of boxwood. Combs are now made mostly of horn, ivory, and vulcanized India rubber. Ornamental combs, worn by ladies, are

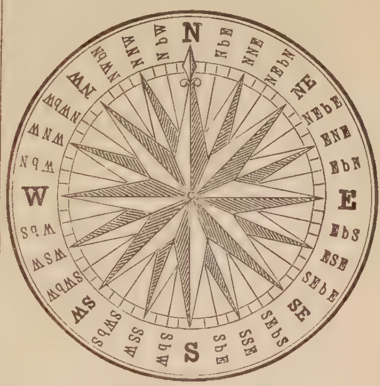
often of gold, silver, and tortoise shell.

In old times combs were made by cutting the teeth with a double saw, the blades of which were set as far apart as the thickness of the tooth to be cut. The teeth were afterward finished with thin files. By this means the material sawed out between the teeth was wasted. But now combs are so made that the material between the teeth goes to make another comb. This is done by cutting them out with a kind of punch instead of sawing them. A plate of horn, tortoise shell, or other material, comes apart when cut, and forms two combs, as shown in the picture, which need only filing and polishing. INDIA RUBBER combs are made by pressing soft rubber into moulds, and "vulcanizing" them afterward.

The word comb is from the Anglo-Saxon *camb*, a comb or crest.

COMPASS, the instrument by means of which sailors are able to steer their course on the ocean when neither the sun nor stars can be seen. If a magnetized (see MAGNET) needle be laid on a piece of cork floating in a bowl of water, one end of the needle will always point toward the north, and the other end toward the south. If you turn it around so that the north pole of the needle shall point toward the south, the cork will turn around in the water until the north pole of the needle points toward the north again. It is just the same in the compass, where the needle is nicely balanced on a little pivot, so that it will turn around even more easily than the cork in the water.

In the mariner's compass the needle has a small piece of AGATE in its centre, with a hole part way through it, by means of which it is balanced on a fine steel pivot standing in the middle of the compass-box. On top of the needle is fastened a card, with the points of the compass marked on it, as shown in the picture, the north end always being over the north pole of the needle. The letters on the points of the compass are read as follows: N, north; NbE, north by east; NNE, north-north-east; NEbN, north-east by north, etc. The whole is enclosed in a round copper or brass box (with a glass over the top to keep the dust out), and this is put in a larger wooden box and so arranged that the steel pivot on which the needle turns will always stand straight up, no matter how much the outer box may be tipped by the rolling of the ship. Thus the needle and the card on which the points of the compass are



Compass Card.

marked are always kept level, and the needle can turn round easily without any danger of being thrown off the pivot. The compass is always kept in a place called the binnacle, where the man who steers can easily see it. On the inside of the compass-box, on the side toward the ship's bow, is a black vertical (up-and-down) line. In steering, the helmsman keeps the point on the card toward which he wishes to go always on this line. For example, if he has been sailing directly north, and wishes the ship to go north-west, he turns the ship's bow toward the left until the point marked N.W. on the compass-card comes under the

black line in the compass-box. By keeping this point always on the line, the ship's bow will always point to the north-west.

The compass used by land-surveyors differs somewhat from the mariner's compass, but is the same in principle. The miner who has to work deep in the earth finds the compass as useful as the sailor does at sea.

The Chinese used the compass in some form at a very early period, but it was not known in Europe until the twelfth or thirteenth century.

The **Compass Plant** is a perennial plant, growing on the prairies of the Mississippi valley from Minnesota to Texas, the edges of whose leaves point north and south. It has a stout stem three to five feet high, with four or five rough bristly leaves each twelve to thirty inches long, and bears yellow flowers. The leaves, which are toothed much like a dandelion leaf, stand up stiff and flat, with their faces to the rising or the setting sun. This, of course, makes the edges point north and south. The compass plant is often very useful to the traveller lost on the prairies.

The word compass is from the New Latin *compassus*, a circle, and the compass is so called because its card has on it all the points round the circle of the horizon.

COPAL, the resinous juice of trees which grow in Mexico, South America, the East Indies, and Africa. It is obtained by cutting notches in the tree, into which the sap runs and hardens. It comes in small round pieces, colored from pale yellow to dark brown, and almost without smell or taste. Its chief use is in making very fine VARNISH and lacquer, much used in the arts.

The word copal is from the Mexican *copalli*, resins.

COPPER, one of the principal ELEMENTS and METALS. Copper was one of the first metals known to man, and was in use before iron. The ancient Egyptians cut their hard granite monuments with copper chisels, which they are supposed to have known how to harden, in some way now forgotten. Almost all the ancient nations used it largely in making BRONZE statues, household ornaments and articles of use, weapons of war, coins, etc.

But little copper is found in the native state—that is, as pure metal—the most being from the mines on Lake Superior and from Peru and Bolivia. The copper of commerce is chiefly made from the ores of copper, of which there are several kinds; the carbonates of copper, in which the metal is mixed with CARBONIC ACID; the oxides of copper, in which it is mixed with OXYGEN; and the sulphurets of copper, in which it is mixed with SULPHUR and iron. One of the most beautiful of the carbonates of copper is malachite, which looks like stone. and is marked with stripes and circles of different shades of green, and takes a fine polish. It is cut into thin layers and used as a VENEER for costly furniture, and it is made also into jewelry and ornamental articles. Much of it is found in Siberia, and the Russians are very skillful in working it.

There are several ways of getting copper out of its ores. The carbonates and oxides are smelted in great furnaces with charcoal, by which the pure copper is at once melted out of them; but the sulphurets, from which copper is mostly obtained, have to be smelted many times before all the sulphur and iron are got out of them. They are usually made first into what is called "regulus," or "matt," which still has in it much sulphur, iron, etc. The matt is afterward refined and made into pure copper by several more smeltings. Another plan for getting copper out of its ores is to dissolve it with acids, and then to collect the metal from the acids. Great quantities of matt and of cop-

per ore are sent yearly from different countries to Great Britain, and particularly to Wales, where are the largest copper-smelting works in the world.

Copper is much used in the arts, and is very valuable on account of its strength and the ease with which it can be hammered into plates and drawn into wire. It is alloyed (see ALLOY) with gold and silver to harden those metals for the making of coins and jewelry; with tin for making BRONZE and bell metal; with zinc for making BRASS, and with nickel and zinc for making German silver. Great quantities of copper are drawn into wire and rolled into sheets. Sheet copper, or sheathing, as it is called, is put over the bottoms of ships, because it oxidizes or rusts very slowly in sea water, and because its rust is so poisonous that shell-fish will not stick to it. Copper is also used for the nails and bolts of ships, because its rust does not destroy wood as the rust of iron does. Maps and some other kinds of engravings are usually engraved on copper plates, because it is soft and easily cut, and has a fine grain. Many compounds of copper are also very useful. Among these are the oxides, one of which is used to stain glass green, and another to color it red. The sulphate of copper is " blue vitriol," used in dyeing, calico-printing, ink-making, and for preserving timber. The carbonate of copper, " blue verditer," is largely used as a paint; and another form of it is a green paint called Bremen green. Brunswick green is another compound of copper (see VERDIGRIS).

The largest copper-producing country in the world is the United States; but there are very important copper mines in Chili, Australia, South Africa, and in various parts of Asia. The chief mines in the United States are in Montana, Michigan, and Arizona, though some copper is mined in New Mexico, Colorado, California, Wyoming, Idaho, Utah, and Vermont.

The word copper is from the Latin *cuprum* or *cyprium æs*, Cyprian brass; and the metal was named from the island of Cyprus, the copper mines of which were much worked in ancient times.

COPPERAS. See VITRIOL.

CORAL, the bony frame of the coral animal, which is rightly called

Branching Coral.

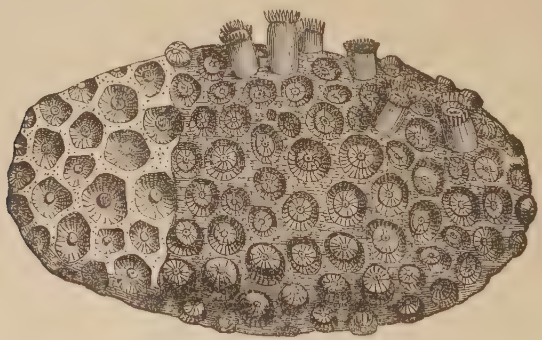
a polyp. It is not made, as was formerly supposed, by the labor of this little animal, but is a growth caused by the food which it takes in, just as the skeleton is in land animals. Indeed, coral may properly be called the skeleton of the coral animal.

Coral animals look like small jelly-like substances, some of which are no wider than the head of a pin; although others are much larger;

they are fixed tight to the bottom of the sea, and never move away from the place where they were born. From their food, and from the sea water which they swallow, they are always taking in carbonate of lime (CALCIUM carbonate), which passes through them and goes to build up the skeleton to which they are fastened, and which grows until they reach the top of the water, when they die, for coral animals cannot work out of water. In this way a column of carbonate of lime is built up from the bottom of the sea to the surface. As there are countless millions of these little animals doing this, great masses of coral have been built up by them. In the Pacific Ocean are coral reefs hundreds of miles long, and many islands are made almost entirely of coral.

There are many different kinds of coral animals, all of which have different ways of building, Some form trunks and branches like trees, some round masses, marked with stars or with twisting furrows like a man's brain, and some great vases filled with things like flowers. Other corals grow in leaves rolled around each other like a cabbage, or imitate the forms of mushrooms, mosses, ferns, and flowers.

In the first picture is shown a piece of one of the branching corals.



Coral with Polyps Growing.

When the animals to which this belonged were alive, each one of the star-like ends was covered with a polyp, the lime from whose body caused the branch under it to grow higher and higher. In the second picture, which shows another kind of coral, several of the polyps can be seen on the top above the surface. On the left side of the picture the soft parts are shown cut away, so that the hard coral can be seen.

Corals are found of many colors, from the deepest black through the different shades of red and yellow to pure white. Among the most beautiful is the red coral, which grows over the rocks on the bottom of the sea in little groves of purple trees, each stalk of which looks like a red, leafless shrub, bearing little star-like flowers. These tree corals generally grow from some shelf of rock, and hang downward, as shown in the picture. The flowers are the little coral animals, of which many grow on each stem. The stems have a kind of soft bark, and under this is the coral, which is hard as marble, and of a beautiful red.

Some kinds of corals grow in all oceans, whether in hot or cold parts of the earth, but the largest reefs grow in the warm waters of the Pacific Ocean. The kind used for jewelry comes mostly from the

Mediterranean and the Red Seas; the dark red is brought from the African coast of the Mediterranean and from the Red Sea, the pink from the coast of Italy, the yellow from the coast of Sardinia, and the black from the Red Sea.

The principal places where the coral fishery is carried on are at the mouth of the Adriatic Sea, along the coast of Sicily, in the strait between Sardinia and Corsica, and off the coast of Algeria. Many people and boats are employed in the business. In some places the fishers dive down and gather the coral by hand, but generally a drag and net are used. The drag is made of two pieces of wood put together in the form of a cross, to the four ends of which is fastened a strong net. The middle of the net is looped up to the middle of the cross, where there is a heavy stone by which the drag is sunk and kept on the bottom. It is let down from a boat, which is slowly rowed along over the places where the coral grows, and the pieces broken off get tangled in the net and are drawn up into the boat. Coral jewelry is made chiefly in Naples and Marseilles.


Red Coral.

Coral was much valued in ancient times. The Gauls adorned their helmets, shields, and weapons with it, and the Romans wore pieces of it as ornaments and as charms. When a Roman baby was born, a coral necklace was put round its neck, because it was thought to keep off diseases; and sometimes it was even taken as a medicine.

The coral ANIMAL belongs to the sub-kingdom of the radiates.

The word coral is from the Latin *corallium*, Greek *korallion*, the name given by the Greeks to red coral.

CORDUROY, a thick kind of cotton stuff, made with ribs or cords. The best corduroy is woven with a twill (see CLOTH).

The word corduroy is from the French *corde du roi*, the king's cord.

CORK, the outer bark of a kind of an oak which grows in countries around the Mediterranean. It is taken from the trees in July and August. Only the outer BARK is cut off, the inner or living bark being carefully kept so that the tree shall not stop growing. The cork-cutter has a sharp-bladed axe, the handle of which is made at the end like a wedge. He first makes several cuts through the outer bark up and down the tree, and then divides these long slabs by making several cuts entirely round the tree. The bark is next pounded, which separates it from the under bark, and the pieces are then easily raised up and prized off with the wedge-shaped handle. The bark is first taken off from a tree when it is fifteen years old; but the cork is not worth much. It takes about ten years for it to grow again, and it is then cut again. This crop is worth more than the first, but is still not very valuable. After this the cork is cut every eight or ten years, and grows better at every cutting. It is said that a tree thus barked will live a hundred and fifty

years. The slabs are first soaked in water, and then dried. When nearly dried they are heated over a fire of coals which blackens them and closed up many of the little holes. They are afterward flattened by pressing them under weights.

Cork stoppers for bottles were formerly cut by hand with a very sharp knife, and many are still made in this way in foreign countries; but most corks are now cut by a machine first made in the United States. Cork is used also in making cork jackets and other kinds of life-preservers, life-boats, soles for shoes, and other things. A paint called Spanish black is made by grinding the charcoal of burnt cork chips in oil.

The word cork comes from the Latin *cortex*, bark.

CORN, the common name of the Indian corn or maize plant and its grain. In the United States the word corn is understood to mean Indian corn, but in Scotland the name is usually given to oats, in England to wheat, and in Russia to barley and rye. Properly the name belongs to any kind of GRASS, the seeds or fruit of which are used for food, such as WHEAT, RYE, BARLEY, OATS, maize, RICE, and MILLET. These are almost the only grasses whose seeds are large enough for food, and they form a class by themselves called the cereals (Latin, *cerealia*), from Ceres, a heathen goddess, who was supposed to be the giver of all kinds of corn. The cereals are all annuals—that is, they have to be newly planted every year, and wither and die after their seed have ripened; and they all grow poorer year by year if not well cultivated.

Indian corn was not known to Europeans before the finding of the New World, where it first grew. It was grown by the Indians throughout both North and South America. The Mexicans had a goddess of maize named Centeotl, who had a statue in the great temple in Mexico. She was sometimes called Tonacajohua, which means "she who sustains us." The Navajo Indians say that they got maize from a turkey-hen that came flying to them from the morning star and shook from her feathers an ear of corn. The Indians of Massachusetts had a tradition that a crow brought them a grain of corn in one ear and a bean in the other from their great god Kautantowit's field in the southwest, and thus enabled them to make "succotash," a dish made of green corn and beans boiled together, of which they were very fond. The Indians cultivated great fields of maize, and both ate it green and laid it up for winter food, and the early English settlers soon learned its use from them. Some corn grows not more than two feet high, while some in the south reaches eighteen feet, or three times the height of a man. The ears and grains are of many different sizes; a kind growing in Brazil has ears no larger than a man's little finger, with grains about as large as mustard seed, while Southern corn has very large ears, and grains half an inch long. The grains differ also in shape and color: some are flat, long, and pointed, some round and blunt, some smooth, some dented at one end, and some wrinkled all over; and the color varies from white through yellow, red, brown, and purple, to black, and sometimes several colors are seen on one ear. But it is thought that all the kinds came from one original kind, and that the changes have been brought about by differences in climate and soil.

Indian corn is one of the most important articles of food in the world and is more used than any other grain excepting rice. It is eaten in many different forms. When unripe it furnishes green corn, highly esteemed as a vegetable, and is made into succotash. Large quantities of green corn are put up every year in tin cans for use in winter. Ripe corn broken or ground into

coarse grains is called "hominy," or "samp," both of which are Indian words; but sometimes the whole grain of corn, with only the outer skin rubbed off by pounding, is called samp. Corn is ground also into meal, from which are made many kinds of bread and cakes, such as Johnny-cake in New England, hoe-cake in the Southern States, and *tortilla* in Mexico and Central America; and a kind of pudding called hasty pudding or mush in the United States, stirabout in Ireland, and *polenta* in Italy. Some kinds of corn are called popcorn, because they will pop open and turn inside out when heated over a fire. This is caused by the oil in the grain, which, turned into gas by the heat, bursts open the grain. The popped kernels, which are much larger than they were before, and are pure white, are largely sold, both separately and when made into pop-corn balls by sticking them together with syrup made by boiling sugar. The grain, the stalks, and the leaves of corn are much used for feeding cattle, and the grain and the meal made from it are often fed to horses. The cured stalks and leaves are called fodder.

The maize plant and its grain are manufactured into many valuable articles. Very good paper has been made from its leaves and husks, and the husks are used for filling mattresses, and for plaiting into mats and many other useful articles. Both syrup and sugar have been made from the juice of corn stalks, but they are not so good as those from sugar cane. Syrup made from the grain of corn is much used instead of sugar by confectioners and brewers. The starch of corn, under the names of "corn starch," "maizena," etc., is used for making puddings, cake, and blanc-mange. Corn contains a good deal of oil, which burns freely in lamps; and in some of the Western States, where wood is scarce, corn on the cob is sometimes burned for fuel. Large quantities of corn are made into WHISKEY, which, from having been first largely manufactured in Bourbon County, Kentucky, is generally called Bourbon whiskey; and it is also used instead of malt for making beer.

When the ripe corn has been gathered from the fields and piled up in the barn, it is the custom, in many parts of the country, for the boys and girls to form a party to husk it—that is, to pull off the leaves and silk with which the ears are covered. These gatherings, which are called husking parties, are often very merry, each one working hard to see who can do the most. Some fine pictures have been painted of husking parties.

The word corn is Anglo-Saxon, and means any kind of grain.

CORNUCOPIA, an emblem of plenty, a horn overflowing with flowers and fruits. It is used as an ornament in architecture, and in sculpture is often put into the hands of statues of Plenty, Liberality, etc. The old Romans made it belong to Ceres, the Goddess of Harvest, whose statues always show the cornucopia in her hand or on her person, overflowing with the fruits of the field.

The word cornucopia is Latin, and means horn of plenty, from Latin *cornu*, a horn, and *copia*, plenty.

CORSET, an article of dress worn by women. Corsets are usually of strong cloth, made stiff with flat rods of whalebone or steel, and with an opening behind closed up by a lacing. They are intended both to sustain the figure, and to change the form when it is not good. Corsets properly worn are not injurious, but when laced tightly to make the waist small, they squeeze up the vital organs of the body, spoil its form, and seriously injure the health.

The word corset is from the French *corselet*, a diminutive of *corps*, Latin *corpus*, body.

CORUNDUM, an oxide of ALUMINUM, a mineral second only in hardness to the diamond. EMERY is an impure kind of corundum. Corundum is found chiefly in India, China, and Siberia, and in the United States in North Carolina and Georgia. In Georgia it is quarried in large blocks which are crushed, rolled, and sifted in different grades, the finest being called flour. It is largely used for grinding and polishing, generally by means of corundum wheels.

Corundum is often found in the form of precious stones; when blue it is called sapphire, and when clear and colorless, white sapphire. Red varities are known as ruby or oriental ruby, the word oriental being added to distinguish it from inferior stones, such as spinel, also called ruby. Other colored corundums too are called oriental; thus, the yellow kind, sometimes called yellow sapphire, is usually termed oriental topaz; the purple ones oriental amethyst; and the green, the rarest of all, oriental emerald.

The word corundum comes from *kurand*, the Hindu name of the mineral.

COTTON. The cotton plant grows in the hot parts of both the Old and the New World. There are three general kinds—herb, shrub, and tree cotton. On herb and shrub cotton, the first of which is only a little plant, and the second about as large as a currant bush, grow what is called "short staple" cotton, or cotton whose down has short fibres or threads; and on tree cotton, which is two and a half to three and a half times as high as a man (15 to 20 feet), grows "long staple" cotton, whose down is very long, strong, and silky. Most of the cotton raised in the United States is short staple, only a little long staple grows on the islands and a few other places along the coasts of the Atlantic and Gulf of Mexico, whence it is sometimes call sea-island cotton. The cotton tree grows also in India, China, and the north parts of Africa. In India the Hindus make a very fine silky cloth out of its down, which they use for turbans.

Planting. The cotton plant is raised from the seed, which in the United States is planted in March and April. It blooms in June. The blossoms, which look like that of the holly-hock, is straw color in the morning, white at noon, pale pink in the evening, and a purplish pink the next morning. After the flowers fall the pods or bolls, which contain the seeds and the cotton, grow very fast, and soon burst open, forming bolls that look like snow-white wool. These open first early in August, but the plant continues to bloom and to ripen its bolls until frost comes. The fields look very beautiful at this time, with the white bolls mingled with the bright green leaves of the growing plant.

Picking and Ginning. Cotton is usually picked by hand, but a machine has been invented, worked by two mules, which will pick 300 pounds an hour. In hand picking, the pickers walk between the rows, gather the down from the open bolls, and put them into bags which they carry tied around the neck or waist. As each bag is filled it is emptied into baskets at the end of the rows. The cotton, as picked from the boll, contains the seeds, which are so mixed up with the down that it takes much labor to separate them. When cotton was first raised in this country the seeds were picked out by hand, but this is now done by the cotton-gin, a machine invented by Eli Whitney, an American, in 1793. In this machine the cotton down is caught by circular saws set round on a roller and working between bars. These bars are so close together that the seeds cannot get through, while the down is caught by the saw teeth and pulled through easily. The down is then brushed off the saw teeth by stiff brushes turning round

under the roller, and after passing between rollers comes out pressed into a long thin sheet.

Cotton Seed used to be left to rot at the gins, though some was put upon the land as a fertilizer; but a few years ago machinery was invented to press out the oil, and now it has become a great business. The oil is used for lamp oil, for making soap, glycerine, candles, butter, and lard, for oiling machines, for mixing with paints instead of linseed oil, for dressing morocco, for eating instead of olive oil, and for mixing with other oils. The part left after the oil has been pressed out, called "cotton-seed cake," is used for feeding cattle.

Baling. After the cotton has been ginned, the next work is putting it into bales and pressing it. This is done in presses worked usually by hand or horse power, but sometimes by a steam-engine. In the United States the bales are generally from 400 to 450 lbs. in weight, or about three times as heavy as a man; but in other countries they are made much lighter. In the East Indies, which, next to America, raises the most cotton in the world, the bales are made small enough to be carried on the backs of camels to the River Ganges, down which they are taken in boats to the ships at its mouth. The East Indian cotton is not so good as that raised in this country, because its threads are shorter and it cannot be spun so easily. Most of it is sent to China. A good deal of cotton is raised in Egypt, but the best African cotton is sent from Algeria. Good cotton is also raised in South America and in the West India islands. The yellowish color of the cotton commonly called Nankeen is not made by dyeing, but is the natural color of a kind of cotton which grows near Nankin, China, from which place it gets its name.

Spinning. In old times cotton was always spun into thread by hand. This was the common daily work of unmarried women in almost all families, and from this such women came to be called "spinsters." The spinner fastened a bunch of cotton, which had been carded or combed out straight, to the end of a forked stick called a distaff, which was held under the left arm or stuck into the belt. The cotton was then drawn out and twisted with the right forefinger and thumb, and the thread was wound upon a stick called a spindle, which was made to whirl round so as to twist it. This had a slit in one end, and whenever enough thread was spun for the spindle to reach the ground, it was wound up and the thread fastened in the slit. Afterward the hand spinning-wheel was brought from India, where it had long been in use. This was a large wheel around which was a band or cord which also went round the spindle. When the wheel was turned round slowly with the hand, the spindle was made to turn very fast. The thread was hooked on to a little hook on the end of the spindle, and formed by the fingers as the spindle twisted. This was the kind of wheel used by our grandmothers for spinning cotton and flax, and some of them may still be seen in the garrets of old country houses.

Cotton is now spun in factories by machines, which work so fast that one man can do as much work as several hundred men could do on spinning wheels, and the thread, or yarn, as it is usually called, is made much finer and evener. Indeed, thread so fine has been spun that a pound of cotton has been made into a yarn so long that, if stretched out, it would reach more than 100 miles. Before spinning, cotton from the bales has to be cleaned and carded, so that all the threads in it shall lie in the same way. It is next drawn, or made into a loose kind of thread, which is much too thick to be spun into yarn, and then twisted a little by a machine called the roving-

machine. The rovings are afterward made into yarn by another machine called the mule-jenny. The yarns thus made are of many kinds, differing in weight and in firmness, and from them are made the various kinds of thread, such as sewing thread, lace thread, stocking thread, etc. All these are made by twisting together two or more yarns, some of them, especially sewing thread, being passed through water or very thin starch, which makes the thread harder and stronger. Thread is tied up in hanks to be bleached or dyed, and is afterward wound upon bobbins, from which it is wound upon small spools or reels, or made into balls. (See CLOTH.)

History. When cotton was first spun and woven is not known. Herodotus was the first European writer to mention it, about 450 B. C. Pliny says that Queen Semiramis was the first to spin it, and the Peruvians told the Spaniards that they were taught its use by Manco Capac. Cotton cloths have been made in India from the most ancient times, and Dacca muslins, so thin that they were called by the poets "webs of woven wind," were prized by the Phœnicians, Greeks, and Romans. The Chinese cultivated cotton in the seventh century A. D. for its flowers, but did not raise it for its fibre until about the thirteenth century. Columbus found cotton in use in Hispaniola, and Cortez in Mexico. In 1664 some people from Barbadoes brought cotton seed to North Carolina with them and planted it on the Cape Fear river. This is thought to have been the first planted for use in this country.

The word cotton comes from the Arabic word *qutun*, cotton.

COUGUAR. The early settlers in the United States called this animal the catamount, or mountain cat. It was also sometimes called the painter (for panther), and some have called it the puma, American lion, and American tiger. The couguar is much like the PANTHER, but is smaller. Its fur is reddish-brown above and white below, and the tip of the tail is usually black. In the forests of North America it lives mostly on deer, which it catches by lying in wait among the branches of trees near where the deer go to drink, and springing down upon them as they pass under. On the great plains of South America it feeds mostly on wild cattle, killing a great many to suck their blood. The couguar may be easily tamed, and has been known to show much affection for its master.

The couguar is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the cat family, which includes also the LION, TIGER, LEOPARD, PANTHER, JAGUAR, LYNX, and common CAT.

The word couguar is shortened from *cuguarcuara*, the South American Indian name of the animal.

CRAB, a kind of shell-fish with ten legs, the front pair of which have strong claws shutting like pincers. There are many kinds of crabs, some

Fig. 1.—First Form of a Crab.

of which live in salt water, some in fresh water, and some mostly on land. The common salt-water crab lives among the rocks, generally along the shore, but is also found

in deep water. It is covered with a hard shell, made, like the shells of oysters and other such shell-fish, of lime got from sea-water, which, when once formed, never changes its size; therefore, as the animal grows, it has to cast off its shell and get a new one. When very young it does this quite often, but after it has got its growth, only once a year. When the time comes for this, the crab crawls away into some lonely place or into some crack in the rocks where its enemies cannot catch it while naked. The upper shell becomes loosened round the edges as the new shell grows under it, and finally comes off, but the shells of the claws do not open and the crab draws out its legs through the narrow joints without harm. As the new shell hardens slowly, crabs are in much danger at this time of being eaten by fishes. They are often caught while the new shell is growing, and sold as soft-shell crabs, which are much esteemed for eating, being liked better than hard-shell crabs.

The common crab will lay as many as 20,000 eggs, which are generally red or yellow and very small. They are not left in the sand like the eggs of fishes, but are carried around by the female, hung on to little hairs under the tail, until hatched. When born the crab is a swimming animal very different in shape from the grown-up crab, as will be seen in Fig. 1, which shows one much enlarged. In time it changes into another form, in which the upper part is much like the body of a full-grown crab, but with the tail still on it. At last the tail comes off, and the little animal becomes a crab, but so small that eight of them put in a line would not be more than an inch long. When full-grown it is often larger than a man's hand.

The **Hermit** or **Soldier Crab** has no shell on the hinder part of its body, which sticks out somewhat like a tail. As this part is apt to get hurt or broken off, the crab looks for the empty shell of some MOLLUSK, and having found one to fit, backs into it and makes it its home, dragging the

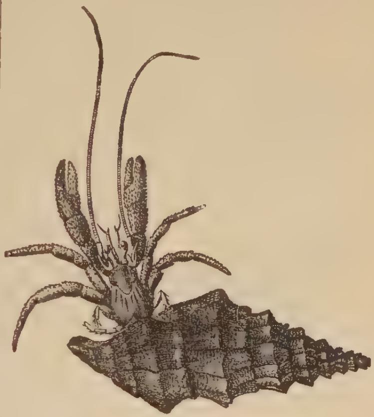


Fig. 2.—Hermit Crab.

shell around with it wherever it goes. This habit of living alone in a shell has given this crab the name of hermit crab (Fig. 2). When it grows too large for the shell, it leaves it and looks for another one, and fierce battles often take place between different crabs for the possession of the best shells. From this they get the name of soldier crabs.

The **Fiddler Crab** (Fig. 3) is so called from its resemblance to the

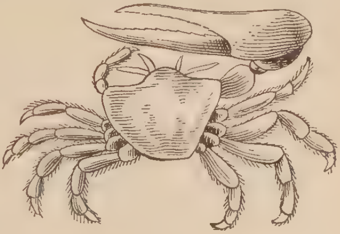


Fig. 3.—Fiddler Crab.

player on a bass-viol. The male has one very large claw which he holds up when running, sawing across it with the smaller one in a very amus-

ing way, much as a viol player uses his bow. Fiddler crabs, unlike other crabs, live in pairs, a male and a female keeping house together. Mr. Fiddler builds the house, goes about and collects the food, and fights the battles, while Mrs. Fiddler, who has only small claws, stays at home and takes care of the family. In building the house, which is generally a hole in the sand one or two feet deep with a little room at the end, the male digs until he has got sand enough for an armful, when he holds it in his great claw against his body, scampers to the door and throws it with a quick flirt on to a heap near by. If a man were as strong in proportion as a fiddler crab, he ought to be able to take up at each shovelful a fourth of his own weight, throw it six to twelve feet, and build up between every two tides a heap eight to fourteen feet high. The male fiddlers often fight each other and lose their claws in battle, but the wound soon heals, and when they shed the old shell and get a new one the claw grows again. Fiddlers live largely on seaweeds, but they eat also flies, mosquitoes, and other tidbits that are swept up half-drowned by the waves. All such things he collects in his larder before the tide rises, and when the first wave rolls over his house and closes the door with sand he is sure to be safe with his wife within.

The **Oyster Crab** (Fig. 4) is a small kind that lives inside the shell of the oyster, the clam, the mussel, and other MOLLUSKS. We often see them in oyster stews, their shells turned red by cooking. It is said that only females are found thus, as the male crab seldom goes into the oyster. A pretty story grew up around these little crabs in the olden time. It is said that the *pinna* of the Mediterranean, a mussel somewhat like our salt-water mussel, was eyeless and needed someone to tell it when to close its shell to escape the jaws of hungry fish; so it invited the little crab to live in its house and in return for its services as doorkeeper gave it protection. Thus the oyster crab got the name among the ancients of *pinnotheres*, guardian of the *pinna*.

Fig. 4.—Oyster Crab.

The **Robber Crab** of the Indian and Pacific oceans is a very large land crab, which feeds upon cocoanuts, climbing the trees and breaking open the fruit with its claws.

The crab belongs to the CRUSTACEAN class of the *articulata*, or jointed ANIMALS.

The word crab is from the Anglo-Saxon *crabba*, a crawfish.

CRANBERRY, the fruit of a plant which grows mostly in cool climates, in the northern parts of Asia, Europe, and America. It is a little smaller than a cherry, and is bright red or pink when ripe. The cranberry thrives in damp marshy ground, over which its vines spread in a thick mat. There are large cranberry swamps in Massachusetts and New Jersey. The fruit is picked usually in September and October, and packed in kegs or bottles with water. It is very sour, and is much used for making pies, tarts, sauces, etc., and is often carried to sea as a preventive of scurvy. The Indians used to make poultices of it to take the poison out of arrow wounds. In Siberia wine is made from cranberries.

The word cranberry is said by some to be rightly craneberry, but the reason of it is unknown.

CRANE, a large bird with a long, sharp, straight bill, long neck, and long legs. Cranes live mostly in marshes and muddy flats. They usually go to warm countries in winter, and come north again in the spring, flying mostly by night in large flocks at a great height. One always leads, and the rest follow in

two lines so as to form a triangle, making loud cries as they fly. When the leading one gets tired he goes behind and another one takes the head of the line. Cranes live chiefly on fish, small quadrupeds, insects, seeds, and roots. They build their nests in tall grass, of sticks and other coarse things, loosely put together, and lay two bluish-white eggs. Both male and female sit on the nest.

The **Whooping Crane,** called also the American and the white crane, is found chiefly in the South Atlantic and Gulf States, but goes as far north in the summer as Minnesota and Dakota, where it breeds. When full-grown it is white with black wing tips, black legs, red head, and dusky green bill. The young birds are bluish-gray marked with brown.

The **Sand-hill Crane,** found in the Southern and Western States, is smaller than the whooping crane and has bluish-gray plumage, marked when young with brown. The sand-hill crane is easily caught and tamed, and it becomes very fond of man and sometimes of animals. One became much attached to some pigs and followed them around wherever they went. It is very imitative too and will try to do what it sees others do. One belonging to a farmer used to fly up on the hay stack where a boy was tramping down the hay and tramp around just as he did. When the farmer was ploughing it would take the lines in its beak and strut after the horses in a very amusing way.

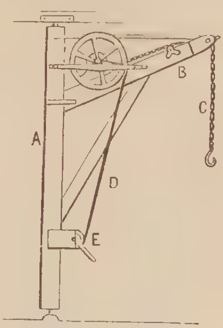
There are several kinds of cranes in Europe during the summer, but as soon as cool weather comes they fly over the sea into Africa, and some go even to Southern Asia. In ancient times there were many queer stories told about these birds. The Egyptians said that they went every year to the sources of the Nile to fight the Pygmies, a race of dwarfs who lived in caves. These little men rode on rams and were armed with bows and arrows, but according to Pliny the cranes were victorious and drove them out of their city.

Another story is about the poet Ibycus, who, while on his way to the Olympic games to strive for the poets' prize, was murdered in a forest by two men. As he was dying he looked up, and seeing a flock of cranes flying by, he cried out "Oh, ye bird travellers, become the avengers of Ibycus!" The next day, while the two murderers were at the Olympic games, a flock of cranes flew over, making loud cries. "Do you see the cranes of Ibycus?" cried one to the other, in a jesting tone. Some persons standing near heard the remark, and as the news of the death of Ibycus had reached there, they caused the men to be arrested. They confessed their crime, and were put to death, and thus was Ibycus avenged by the cranes.

The crane belongs to the order *grallatores*, or wading BIRDS.

The word crane is from the Anglo-Saxon *cran*.

CRANE, a machine for lifting heavy weights. The most common kind is made up of an upright post,

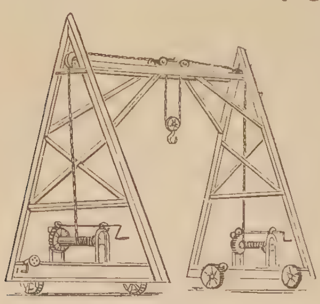


Common Crane.

A, which turns round, with an arm called a jib, B, reaching out from its top, as shown in the picture. On the end of the jib is a pulley, over which passes one end of the chain,

C, the other end being wound round the drum or axle of the wheel. Around the outside of the wheel is wound a rope, D, which also goes round a roller, E, at the bottom of the crane, and is wound on it by turning the handle of the roller. When the hook on the chain is hitched to a heavy weight, such as a box or bale, the rope is wound up on the roller; this turns the wheel above, winding the chain up on its axle, and this lifts the weight. When it is as high as is needed, the crane post is turned and the weight is thus swung round and put where it is wanted. This kind of crane is very useful in unloading goods from ships and loading them again into wagons or carts.

The travelling crane is made up of two frames moving on wheels, and joined together at the top by a strong frame. On each of the upright



Travelling Crane.

frames is a barrel, on which the chain is wound up, and which is turned by a handle called a WINCH. When both the winches are turned, the chain is wound up on both the barrels, and the weight, which is hung on the hook in the middle, is raised up; but if one winch be turned so as to wind up the chain, and the other one so as to unwind it, the weight will neither rise nor fall, but will move toward the side where the winch is winding up the chain, the little wheels on the top frame moving from side to side as the weight is pulled one way or the other. The travelling crane can easily be moved anywhere, and thus carry a heavy weight to another place. This kind of crane is much used in large buildings, in stone yards, and on docks.

There are many other kinds of cranes, some of which are worked by steam and are made strong enough to move immense weights. One kind, strong enough to lift a ship out of the water, is called a derrick, after Theodoric, the name of a noted hangman at Tyburn in the seventeenth century, because it is shaped something like the gallows used by him.

The word crane is from the Anglo-Saxon *cran*, the crane bird; and the machine is so named because its arm looks something like the neck of that bird.

CRAPE, a kind of thin silk gauze worn chiefly for mourning. It is woven out of raw silk, the threads being tightly twisted, and afterward stiffened with gum, which as it dries partially untwists the threads and gives the fabric its rough or crinkled look. It is usually dyed black, but is sometimes used white as a trimming for dresses. China crape is a beautiful kind of smooth and heavy silk, made in different colors, and used for rich dresses, shawls, etc.

The word crape is from the French *crêpe*, which is from the Latin *crispus*, crisped or curled.

CRAWFISH, a small shell-fish, which looks much like the lobster, found in running streams, ponds, and lakes. It changes its shell every year, gaining in size each time. The new shell becomes hard in a few days. When any of its claws or feet are lost by accident, they will grow out again. Crawfish conceal themselves by day and come out of their holes at night to feed. They live mostly on animal food, both living and dead, and will even eat decayed things. They love to burrow in the mud, and they often dig under the levees of the rivers in the South so

as to undermine them and cause freshets. Crawfish are much esteemed for food, and are also largely used by fishermen for bait.

The crawfish belongs to the CRUSTACEAN class of the *articulata*, or jointed ANIMALS, and to the same family with the lobster.

The word crawfish is from the old English *creveys* or *crevish*, which is from the French *écrevisse*. It is sometimes spelled crayfish.

CRAYON, a kind of pencil for drawing, sometimes called a pastel. Crayons are made of chalk, pipe clay, gypsum, or charcoal, and are of all colors. The materials are ground up into a paste with some gum, starch, wax, soap, sugar, etc., to make them hold together, and are then moulded into little rolls of the proper size. The paste is colored with different things, such as Naples yellow, indigo, vermilion, umber, and carmine, according to the color wanted. Black crayons are made of black chalk or of charcoal.

The word crayon is French, and comes from the Latin *creta*, chalk.

CREOSOTE, a yellowish, oily liquid, with a hot bitter taste, and a smoky smell. It is made up of CARBON, HYDROGEN, and OXYGEN, and is usually got by distilling (see ALCOHOL) wood tar. Meat is cured by smoking it because there is creosote in wood smoke; and if a little creosote be put into the salt and water in which hams and tongues are soaked it will give them a fine flavor. Creosote is used as a medicine to stop vomiting, to dress sores, and to cure toothache. When put into the hollow of an aching tooth, it stops the pain by deadening the nerve. Meat soaked in creosote and water will keep sweet a long time, and wood soaked in it is preserved from dry rot.

The word creosote means flesh-saver, being from the Greek words *kreas*, flesh, and *sozein*, to save.

CRESS, the name given to several kinds of plants used for salad. Among them are the water-cress, or nasturtium, which grows beside running streams; the garden-cress, or peppergrass; and the winter-cress, which is found about hedges.

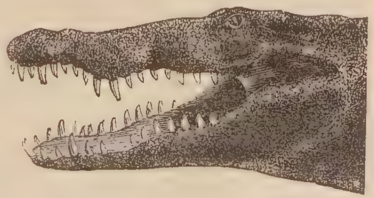
The word cress is from the Anglo-Saxon *cærse*.

CRICKET, a small insect belonging to the same family with the grasshopper and the locust. The hinder legs of crickets are very long and the thighs are strong and formed for leaping. The wings, of which there are four, are straight, and when not in use are folded lengthwise along the back. The shrill noise of crickets is made by the males only by raising the fore wings and rubbing them on the hind wings. There are several kinds of crickets in the United States: the principal of which are the black mole cricket, so called because it is like the mole in its habits, which lives in burrows in the ground; and the tree cricket, a very delicate insect of an ivory yellow color, which lives mostly on trees. In old times people feared to kill the cricket, as it was thought to bring good luck to the house where it lived.

The cricket belongs to the order *orthoptera*, or straight winged INSECTS.

The word cricket in French *criquet*, from *criquer*, to creak, to chirp.

CROCODILE, a large reptile, found in tropical waters all over the world,



Head of Florida Crocodile.

excepting in Europe. The crocodile of the Nile was one of the sacred animals of the Egyptians, who kept live ones in their temples, where they

were cared for by the priests and ornamented with gold and precious stones. When they died their bodies were embalmed and carefully buried. Many crocodile mummies may be seen in museums. Crocodiles are found also in Asia and in Australia. There are two kinds in America, one of which is found in the West Indies and South America, and the other in the West Indies, Central America, and Florida. The Florida kind grows from ten to twenty feet long, is brown and black on top and yellow below, and has a long head as shown in the picture.

The word crocodile is from the Latin *crocodilus*, Greek *krokodeilos*, a lizard, crocodile.

CROW. The common crow of the United States is somewhat larger than a pigeon. It has a short thick neck, large head, and large straight bill, and is generally shiny black, though white ones, or ALBINOS, are sometimes seen. Crows live in societies near inhabitated places, especially near farms. Farmers usually call them thievish birds, because they pull up the seeds of sprouting corn and other grain, and they kill a great many of them every year with guns, traps, and poisoned grain. They also put up scarecrows, or figures dressed up like a man or woman, in the fields to frighten them away, and almost every boy who can climb a tree robs their nests. But this is wrong, for although the crows may sometimes do a little damage, they do a great deal of good by eating insects, grubs, and worms, which, if left alone, would harm the corn much more than they do. They also destroy many moles and mice, and even eat decayed things when they cannot get better food. In Japan they are made welcome everywhere on this account, and are never harmed. In the island of Corsica the farmers have a singular way of killing them. They roll up pieces of stiff paper into cones like a cornucopia, glue a piece of meat in the bottom, and smear the upper part with glue, and put them open end up in holes in the fields. The crow plunges its head in, and draws forth not only the meat, but also the cone of paper glued fast to the feathers of the neck. Thus blinded, it rises in the air, but is soon tired out and falls to the ground.

Crows are very sly, cunning birds and are sure to keep out of the way of a man with a gun. When they feed in a field they usually have a watchman perched on a high tree, who gives the alarm when anyone comes near, and when his loud "caw, caw," is heard they fly away to a safe place until the danger is past. Crows eat snakes and frogs, and steal and devour the eggs of other birds. They take great pleasure in worrying small animals, such as the opossum and racoons, and will even chase hawks and eagles.

Some crows go south in winter and some stay where they usually live. They build their nests of sticks, woven with grass, in hidden places in swamps or thick woods, and one pair will often keep the same nest year after year. In some places, where there are no trees and shrubs, crows are said to build their nests of the dried bones of fish that have been thrown upon the shore. The eggs, usually five or six, are bluish-green spotted and marked with brownish-green. While the female is sitting, the male bird waits on her with the greatest care.

The crow may be easily tamed, if taken from the nest when young, and may be taught almost as many tricks as the parrot. It may even be taught to speak a few words. If treated well, a tamed crow will show much affection for its master, and will come when called by its name; but it is very apt to be mischievous and thievish. It will steal and hide away any small thing which it can carry, such as keys, spectacles, and pocket-knives. I have heard of a crow which once stole the key of the

smoke house on a farm, and when the cook wanted to get some ham in the morning for breakfast she had to pull the staple out before she could get the door open. In a few days a new key was bought and then the thief brought back the old one all rusty. This same crow used to take great delight in stealing the dog's and cat's dinner and flying up on to the barn with it; and when it had eaten all it could it would come down and bury the rest. If a strange dog came on the place it would fly on its back and peck and scratch it until it was glad enough to run away. It liked the old cat very well, but when she brought out some new kittens it walked round them flapping its wings and scolding, pulled their ears, and frightened them nearly to death by swinging them round by their tails. This crow could whistle, laugh, call the cows, and make a noise like the dinner-horn.

The crow belongs to the order *insessores*, or perching BIRDS, and to the same family with the raven, rook, jay, and magpie.

The Anglo-Saxons called this bird *craw* from the sound of its voice, and from this comes our word crow.

CRUCIBLE, a vessel or pot in which glass, metals, etc., are melted. Crucibles are generally made of clay mixed with coke-dust, BLACK-LEAD, sand, or broken crucibles. They have to stand so great a heat that they can be used only three or four times. At Krupp's great steel works at Essen, in Prussia, crucibles are used only once and then broken up to be made over again. So many are needed there that 100,000 of them are drying at a time. Crucibles made of porcelain, platinum, silver, and black-lead are used by chemists. Some pictures of the kind of crucibles used in melting glass are given in the article GLASS.

The best crucibles in the world are those made in this country of black-lead or graphite, most of those used in melting metals being of this kind. One half of the material used is black-lead, and the other half is made up of blue clay, kaolin, and fire-sand. The black-lead for crucibles is mostly brought from Ceylon, though some is got from Ticonderoga in New York; the blue clay is German pipe-clay, from Hesse; and the kaolin (see CLAY) is found on Staten Island. The fire-sand, which is nearly pure silica (see SILICON), is got from Martha's Vineyard and Long Island. Crucibles are made chiefly in Philadelphia, Pittsburg, Jersey City, Taunton, Mass., St. Louis, and Bridgeport, Conn., and Mascoutah, Ill.

The word crucible is from the new Latin *crucibulum*, which is from the Latin *crux*, genitive *crucis*, cross; and the name was given to these pots because they were marked in old times with the sign of the cross to keep the devil away from them.

CRUSTACEANS. This class of animals may be called the insects of the sea, because they are like insects in many things. Most of them have compound eyes, or eyes made up of small ones, like those of numerous insects, and they also have antennæ, or feelers, and many pairs of legs; but they are generally strong instead of weak, and are fitted, like FISHES, to breathe in water. They are all covered with shells, not stony like those of mollusks, but softer and made up of rings fitted together, like the bodies of all articulate ANIMALS. Their shell is really an outside skeleton, and is formed, like the inside skeletons of other animals, by a limey matter given off from the BLOOD of the animal itself. It is made up of layers or leaves of lime (CALCIUM carbonate), the outside one of which is generally colored, sometimes dark brown, sometimes yellowish or reddish brown, and sometimes blue-black or green-black. When put into ALCOHOL, ACIDS, or boiling water, the color of the shells of most crustaceans change to red, as is seen in boiled lobsters and crabs.

Crustaceans usually change their shell every year. When the time comes for casting it, the body pines away and grows smaller until it separates in all parts from it; the shell then opens in some part, and the animal works itself out. This changing of the shell is necessary, because after it is once formed it does not grow with the other parts, and in time becomes too small for the body. When the old shell is got rid of, the animal crawls away into some quiet place and waits for a new one to grow.

Most crustaceans have hooked claws with teeth, which they use as pincers, and with which they fight not only against their enemies, but with each other. In these fights they often lose a foot, a feeler, or a claw, but the lost parts grow again in a short time. This is the reason why lobsters and crabs are so often seen with one claw larger than the other; the smaller one has been lost, and has not yet fully grown again. On the coast of Spain a kind of crab is caught for its claw alone, which is much prized for food. When the claw has been pulled off, the animal is thrown back into the sea to let another one grow.

Crustaceans live mostly on the sea coast, among rocks and near the shore; but a few live in deep water. They feed chiefly on other animals, both living and dead. They use their claws in eating, carrying food to the mouth first with one claw and then with the other, in much the same way as human beings use their hands. When a crab catches a mussel with its shell open, it quickly seizes it with one claw so that it cannot close it, and then tears the meat out little by little with the other claw, until the whole is eaten. Large crabs often eat little crabs, tearing them to pieces bit by bit; but lobsters generally kill their prey before beginning to eat it. Crustaceans have a great love for oysters, and some are said to watch for one to open its shell and then to slip a stone in so that it may eat it at its leisure, but this is doubtful.

There are several orders of crustaceans, but only one, the *decapoda*, or ten-footed crustaceans, whose feet are mostly in five pairs, and to which the LOBSTER, CRAB, SHRIMP, and CRAWFISH belong, will be told about in this book.

The word crustacean is from the Latin *crusta*, a crust or shell, and these animals are so-called because they have shells.

CUCKOO. The European cuckoo lives mostly in the warm parts of South Europe, but appears in Great Britain usually in April, and stays until August. Its back, neck, and breast are of a deep bluish-gray, and the under parts are white barred with black. The cuckoo does not make any nest, but has the singular habit of laying its eggs in the nests of other birds, and leaving them to be hatched by them. It is said also that the young cuckoos cast out of the nest the young of the bird which hatches them, and that the bird, not knowing of her loss, raises them as her own. The American cuckoos have not this bad habit. There are three kinds in the United States; but the principal one is the yellow-billed, sometimes called the cow-bird because its notes sound like "cow, cow." It is greenish-brown above and grayish below, and has a yellow bill about an inch long. It lives mostly in thick woods, and builds a nest of sticks and grass on the branch of some low tree. It lays four or five bright green eggs. Its food is chiefly insects, snails, and berries, but it also sucks the eggs of other birds. This bird is found in all parts of the United States—in the North during the summer, and in the South in cold weather.

The cuckoo belongs to the order *scansores*, or climbing BIRDS, and to the same family with the parrot and the woodpecker.

The word cuckoo comes from the

Latin *cuculus*, Greek *kokkux ;* and the bird is so called from the sound of its note in spring.

CUCUMBER. The cucumber first came from India, where it has been cultivated for three thousand years. It was not carried to China until the second century B. C., but it had spread westward before that. The ancient Greeks cultivated it and it was a favorite with the Romans, but no trace of it has been found in ancient Egypt. In its wild state it is very bitter, and it is thought that only long-continued cultivation has made it fit for food. In the United States it is eaten raw, cut up with salt, pepper, and vinegar, or made into pickles, but in Europe it is eaten cooked in different ways. The juice of the cucumber is used in medicine and in making pomades for the hair and cosmetics or liquids for beautifying the skin. Young cucumbers pickled are sometimes called gherkins. The squirting cucumber grows wild in the south of Europe. When ripe the fruit drops off its stem and squirts out all its seeds and juice. A powerful drug called *elaterium* is made from its juice.

The word cucumber is from the Latin *cucumis*.

CURRANT. There are many kinds of currants, of which the red variety is the most common in the United States, where it grows wild. It grows wild also in Northern and Middle Europe and in Siberia. It was not known to the Greeks and Romans, and was not cultivated in Europe until the Middle Ages. The white currant is liked better by some because its juice is less sour. The black currant has a larger berry than the other kinds, and is still less acid. In Russia there is a currrant which bears bright yellow berries.

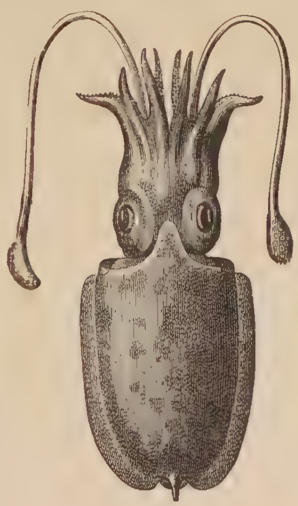
The sourness of the currant is due to malic ACID. Its juice is made into wine, jelly, preserves, tarts, etc. In Russia wine is made from the black currant, in Siberia its leaves are made into a drink something like tea, and in France a cordial called *liqueur de Cassis* is prepared from it.

The currant gets its name from Corinth, in Greece, from whence the small grape called the Zante currant was first brought. The common currant, which is a different kind of plant, was named from this because its fruit looks much like it.

CURRY, an East Indian powder or paste, much used in cooking as a seasoning. It is made of turmeric, coriander-seed powder, pepper, ginger, cummin, mustard, mace, cinnamon, and cardamom, mixed in many ways.

The word curry is the English form of the East Indian *kari*.

CUTTLE FISH. The form of the cuttle fish can be best understood from the picture. It has ten arms



Cuttle Fish.

or legs growing out round the head, two of which are longer than the others. It can walk head downward on these arms on the bottom of the sea, and it can swim by means of them and its fins; but it can swim much faster backward by blowing

water out of its breathing tube, which opens under the head. The hinder part of the body is fitted with a light soft bone the use of which is not exactly known, but some think it acts as a kind of fender to keep the animal from being hurt by striking against things when swimming backward. This bone, which is porous, or full of little holes, is the common cuttle-bone, which we often see in bird cages. Birds love to whet their beaks on it, and they also get from it the lime which they need for the growth of their bones. A kind of tooth powder, called "white coral powder," is made from cuttle-bone, and jewellers make of it a powder called "pounce" for polishing soft metals.

The arms of cuttle fish have on them many little suckers, by which they seize and hold their prey. In stormy weather they sometimes anchor themselves by means of the two long arms, thus leaving their other arms free. They will let these arms be broken sooner than let go of what they have seized. Like other cephalopods, cuttle fish have a bag filled with a black fluid like ink, which they can squirt out to darken the water when an enemy is near. They will also blow out this ink on land. A story is told of an English officer who, after having dressed for a dinner party, walked down on the beach to study natural history, of which he was very fond. He found in the hollow of a rock a cuttle fish, which looked out with its great eyes at him with as much apparent interest as he looked at it; but after a few moments of this fixed gaze the animal ended the interview by blowing a stream of its ink all over the officer, who was obliged to go home and change his dress. The Romans knew of this fluid, and used it for making writing ink, and now the water-color paint called sepia is made from it. Cuttle fish EGGS, which are usually fastened to seaweed, and look like a bunch of black grapes, are used in Italy for making necklaces.

Cuttle fish are found in the sea in all parts of the world, and in some seasons they come to the shore in great numbers. They live mostly on small fishes, of which they kill a great many, even after they have eaten all they want. But they have fierce enemies in the dolphins, which hunt them for sport, as they do little fish, and kill them wherever they can catch them. They are eaten by the people of many countries.

The cuttle fish is a cephalopod animal of the sub-kingdom of MOLLUSKS.

The cuttle fish gets its name from the old English word *cuttle*, a knife, because its bone is shaped somewhat like the blade of a knife.

CYCLE. In 1816 Baron Karl von Drais, of Mannheim, Germany, made a kind of velocipede, called after him

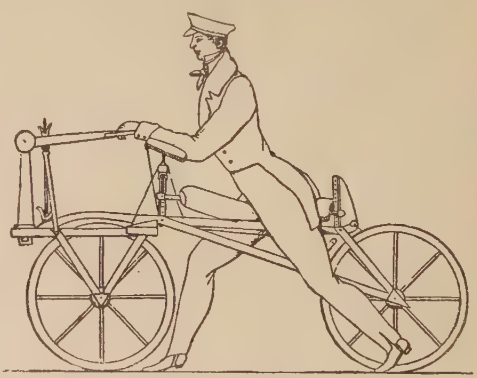


Fig. 1.—Draisine.

"draisine," which was thought at the time to be a wonderful machine. Its form, somewhat like that of a safety bicycle, can be seen in Fig. 1, which is taken from an old picture,

It had no treadles, but was pushed along by the rider's feet on the ground. In 1818 the draisine was introduced into England, and the next year into New York, Boston, and some other American cities, and for a time was popular. Improvements soon began to be made in it; in 1826 a three-wheeled velocipede, to be moved by cranks, or pedals,

Fig. 2.—McMillan.

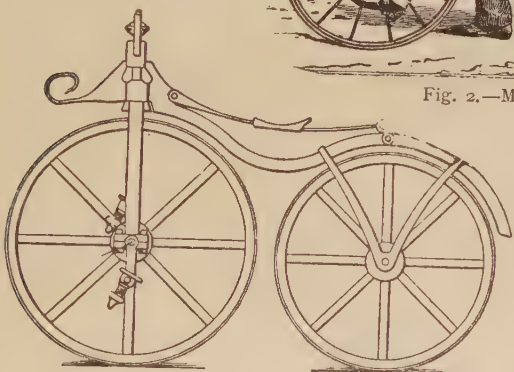


Fig. 3.—Lallement.

was made in France; about 1840 a Scotchman named McMillan fitted pedals to a draisine, and about 1845 another Scotchman named Dalzell made a rear-driving bicycle much like the safety of to-day. In 1865 a Frenchman named Lallement made a similar machine. In 1866 this was patented in this country, and became quite popular for a while, but as it was still an awkward machine it soon went out of use. But the idea was a good one, and inventors kept at work trying to improve it. About 1868 the first real bicycle, with a large front wheel with the saddle above it, and a small hind wheel, was made in England. It is said that a Frenchman suggested making the front wheel larger than the rear one, an American added the rubber tire, and an Englishman put in the ball bearings.

Though this was a great improvement on any machine before it, it was still clumsy and imperfect as compared with the bicycle of to-day. But the inventors kept at

Fig. 4.—Ariel.

work at it, and many new forms appeared, of which the Ariel of 1873 (Fig. 4), the American Star of 1881 (Fig. 5), and the perfected ordinary bicycle of 1886 (Fig. 6) may be taken as examples. Soon afterward the rear-driving chain safety appeared and the large wheels went out of fashion. The safety has undergone many changes in the past few years,

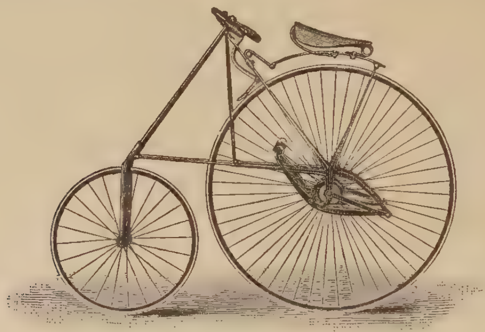


Fig. 5.—American Star.

and many different kinds are now sold. Among the most important additions are the pneumatic and cushion tires, which make it possible to ride with comfort over rough roads. The pneumatic tire, introduced in 1889, is a rubber and canvas tube about two inches in diameter, the hollow of which is filled with air by means of a small air-pump. The cushion, a rubber tire of $1\frac{1}{4}$ inches, with a half-inch hol-

Fig. 6.—Ordinary, 1886.

low, is less costly and far less liable to accident than the pneumatic, but perhaps not quite so fast or comfortable.

Bicycles are ridden not only for pleasure and exercise, but are put also to many useful purposes. In England they are largely used by mail carriers and to some extent in this country. In most European

countries they are now used in the military service, and for many purposes have been proved to be superior to horses, especially for long distances.

Besides the bicycle form, cycles are made also in many other shapes, such as tricycles—with three wheels, of which there are many kinds; quadricycles—with four wheels; tandems and sociables—for two or more riders, etc.

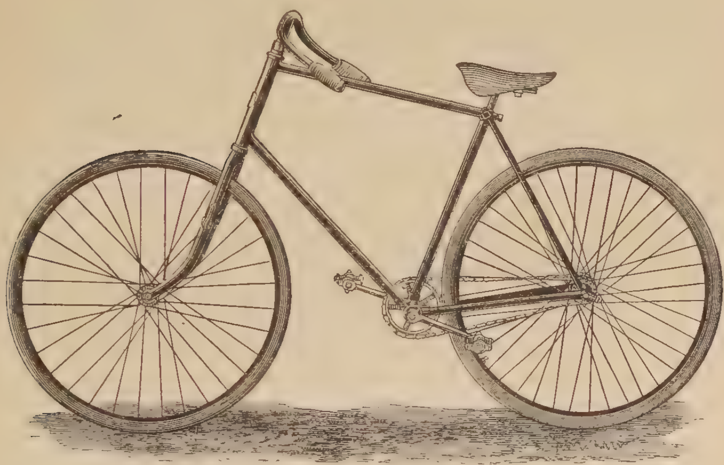


Fig. 7.—Safety.

CYMBALS, brass musical instruments, made of two round hollow plates, played by being struck together, one being held in each hand by means of leather straps. They are used mostly by military bands, but sometimes also in ORCHESTRAS. Cymbals are very ancient instruments, and were used by the Greeks and Romans, and by most Eastern nations. The best cymbals are made in China and in Turkey.

The word cymbal is made from the Greek *kumbalon*, from *kumbos*, hollow.

CYPRESS, a large tree of the same family with the pine, which grows in the Middle and Southern United States. It is sometimes ten or twelve feet thick at the ground, and higher than two four-story houses. The trunk is often hollow and has its bark deeply creased, and all around it, especially in swamps, where it mostly grows, little pointed stumps called cypress knees spring up from the roots. The cypress has fine light-green leaves, which turn brown and fall in the autumn, and its limbs are often hung with moss.

Cypress wood is straight-grained and easily worked, and is much used in carpentry and for making shingles. It is also used for foundations of houses and for piles in wet places, as it will not rot under water.

The word cypress is from the Latin *cupressus*, cypress.

D

DACE, the name of several kinds of small fishes found in fresh-water lakes and streams in the United States. The black-nosed dace, commonly called MINNOW, is found in brooks in New England and New York. It is seldom more than three inches long, is brown above, silvery-white below, and has a dark band running from the head to the tail. It makes good bait for catching other fishes. The fish commonly called the roach, also found in New York and New England, is the roach-dace or silver dace, as there are no roaches in this country. It is dark-brown above, the upper part of the sides bronze-green, and the lower part golden or coppery. The roach-dace is sometimes more than a foot long, but usually about eight or nine inches.

The word dace is sometimes spelled *dart* and *dare*, and is from the French *dard*, dart; the fish is probably so called from its shape, or because it darts in the water.

DAGUERREOTYPE. See PHOTOGRAPH.

DAHLIA, a beautiful flowering plant, first brought from Mexico, but now common in Europe and the United States. The first roots were carried to Europe in 1790 by Humboldt. There are now said to be more than two thousand kinds of dahlias. The roots are eaten in Mexico, but are not thought fit to eat here.

The dahlia is named from Dr. Dahl, a Swedish botanist.

DAISY. The flower called by this name in the United States is not the true daisy; it is a kind of chrysanthemum, and is rightly called ox-eye daisy or whiteweed. It has a yellow centre, from which branch out many white petals or leaves like rays. The daisy is a favorite flower with children. Girls pull off the white petals one by one, saying with one "He loves me," and with the next "he loves me not," and think that their fate in love will be like the words spoken with the last one. The flowers also make pretty chains and ornaments for hats. The true daisy does not grow wild in the United States, but is plentiful all over Europe, and is found almost all the year round blooming in pastures and meadows. It is smaller than the ox-eye daisy and does not grow so high. Its flowers, the edges of which are often tinted with crimson, close at night. This daisy, called gowan in Scotland, is the one noted in poetry and song.

The word daisy is changed from day's eye, which is from the Anglo-Saxon *dæges-edge*, day's eye.

DAM, a bank or wall to hinder the flow of water in a stream. Dams have many uses, such as the storing up of water to turn machinery or supplying aqueducts, the raising of the level of water in rivers to help navigation, etc. They are usually built where the stream is wide, especially where there are apt to be freshets, so that the water when high may flow freely over them; if built in narrow places they have to be made very strong, as there will be great pressure upon them, for the water presses against the dam just as heavily as it does against the bottom. In still and shallow water dams may be built of earth, but where the current is swift

and the water deep they are usually made of solid stone masonry or of timber, or of both together. A dam built to supply water to turn the machinery of a factory is usually made with a channel called a race, which leads the water directly to the WHEEL that it turns; and when several factories or mills get their water power from one dam, a canal is usually dug on one side of it and each factory gets its water through a race leading from the canal.

A **Coffer-Dam** is a dam to keep water out of an enclosed place, usually in the bed of a river, so that digging or other work may be carried on within it. It is used in making the piers for bridges and in clearing away things which hinder navigation. It is made sometimes by driving down several rows of PILES and filling in the spaces between them with clay and gravel, sometimes by sinking to the bottom a crib or kind of box made of strong timbers lined with plank, and sometimes, when the space wanted is small, by sinking an iron cylinder. When the dam is finished, the water is pumped out of it, and workmen can then go down into it to do what is needed.

The word dam is from the Anglo-Saxon *demman*, to stop the flow of anything.

DAMASK, a kind of silk cloth with figures of fruits, flowers, etc., woven in it. In old times handsome and costly dresses were made of it, but now it is used mostly for curtains and furniture covering. Damask is now made sometimes of wool, and sometimes of linen, or a mixture of linen and cotton. It is woven with a twill (see CLOTH) in which the weft threads skip eight of the warp. Linen damasks are used chiefly for table-cloths and napkins. The cloth called diaper is a kind of damask in which the weft skips five threads instead of eight.

Damask gets its name from Damascus, where it was first made.

DANDELION, a plant with a bright-yellow flower, common in the fields of Europe and the United States. Its leaves are eaten for salad, and its roots are sometimes roasted and used for coffee. The juice of the plant is given as a medicine. When it goes to seed it makes a pretty white fluffy ball, which children call "time flower" or "the clock." When blown with the mouth, the white threads fly off, and they tell the time by the number of blows it takes to clear all the threads off.

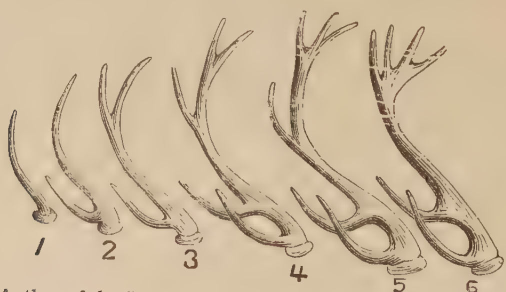
The word dandelion is from the French *dent de lion*, lion's tooth, and the plant is so called on account of its deeply notched leaves.

DATE, the fruit of the date palm. The tree grows well only in a warm, dry climate; it is found chiefly in the countries extending from the Canary Islands and the east coast of Africa to the Valley of the Indus. It is quite tall and straight, and has no branches, but bears at the top a crown of forty to eighty leaves, generally eight to ten feet long, among which the fruit hangs in bunches. It is one of the most useful trees in the world. The trunk makes timber for houses and fences, and wood for fuel; the leaves are used for making baskets, bags, mats, fans, brushes, ropes and cords, and for covering roofs and walls; and the fruit gives food to millions of people. Wine and vinegar are made from the fruit, and a liquor called palm wine from the sap of the tree. The soft pith of the shoots and the young unfolded leaves are eaten under the name of palm cabbage. Oil is made by grinding and pressing the stones of the fruit, and what is left is fed to cattle. In Africa the fruit is one of the chief articles of food, and is eaten either fresh or dried. Dried dates pounded together into a mass, as they are usually brought to this country, make the chief food of the caravans in their journeys through the great desert of Sahara.

The trunk of the date tree is very hard to climb, but the Arabs have an easy way of getting up it to pick the fruit. The climber puts a rope round his back and under his armpits and then round the tree, and ties the ends in a knot. Putting the rope into one of the notches left by the fallen stalk of a leaf, he slips the rope down to about the middle of his back, and then taking hold of the trunk with his hands and knees raises himself up a few inches. Then, while holding fast with knees, feet, and one hand, he slips the rope up with the other hand until it rests on the next notch, and so on until he gets to the top. The clusters of fruit are then picked and thrown down, where they are caught in a cloth held at the corners by other men.

The word date comes from the Latin *dactylus*, Greek *daktulos*, a finger, and the fruit is so called because it is shaped somewhat like a finger.

DEER. There are many kinds of deer, and they are found in all parts of the world, excepting Australia and Africa south of the desert of Sahara. They are generally graceful animals, and are noted for their shyness and fleetness. The males of almost all the kinds have branching horns, which are cast off yearly, new ones growing in their place.



Antlers of the Stag, from the Second to the Seventh Year.

The female deer generally have no horns. The shape of the horns, which are called antlers, differs much in different kinds of deer, some being round with many branches, and some flat and broad. Deer's antlers are not hollow horn, like the horns of cattle, but a bony substance which is really a part of the skull.

The **Red Deer** or Stag is found in the temperate parts of Europe and Northern Asia. It is the principal kind in Great Britain, and large herds are kept in the Highlands of Scotland. A full grown one stands about four feet high at the shoulder; its color in summer is reddish-brown and in winter grayish-brown. The male is commonly called a hart after its fifth year, and the female a hind after its third year. The horns of the male first come like two small knobs which grow out of the skull and push the skin up. The skin on them dies and in time the horns come off. New ones begin to grow at once, and in the second year are something like cows' horns without any branches. When they are of full size the skin comes off, leaving the horns bare and hard. These fall in turn, and are followed the third year by horns with one branch on each. Thus a change is made every year, the antlers increasing in size and in the number of branches each time until the animal has reached old age, when they begin to grow smaller. In the picture the growth of a stag's horns is shown

for six years, the first one being the second year's growth, and so on. When a stag has horns with twelve branches he is called in Scotland a "royal stag."

The skin which covers deers' horns while they are growing is called the velvet, and the horns while so covered are said to be "in the velvet." This skin is full of veins, and from the blood in them the antlers are made. The little creases for the arteries may be seen on the outside of almost any dry antlers. After the antlers are fully grown the supply of blood is cut off from the arteries little by little, and the skin or velvet then dries up and peels off. The deer almost always helps it off by rubbing his antlers against trees.

The **Fallow Deer,** found wild in Western Asia, North Africa, and Sardinia, is the kind often seen in parks in Britain. It gets its name from its fallow or yellowish color, often spotted with white. It is smaller than the red deer, standing about three feet high at the shoulder. The male is commonly called a buck and the female a doe. A young buck or doe is called a fawn.

The **Roe Deer** lives in temperate Europe as far east as Syria. It is the smallest deer in Britain, being often little more than two feet high at the shoulder. Its color is reddish-brown with white on the rump. Its horns are about a foot high and stand erect, branching near the tip. The roe deer loves woods, where it hides in the day, coming out at evening for food. It often does much damage to crops. The male is commonly called a roebuck.

There are several kinds of deer in North America, including the Virginia deer, found east of the Missouri River, the wapiti, or American elk, of the northern and northwestern parts of the United States; the mule deer and white-tailed deer of the Northwest; the black-tailed deer of the Pacific coast; the moose of the north parts of America, and the reindeer.

The **Virginia Deer** is the one usually seen in parks. It is the most beautiful of all the deer, having a graceful form, with long, slim legs, a long neck and small head, large ears, and large, full eyes. The color is reddish-brown in summer and grayish in winter, with the throat and tail always white. It lives on grass in summer, but in the autumn eats many berries, nuts, and acorns, and in the winter feeds mostly on buds and tender twigs. The antlers or horns of the males are full grown in the middle of summer, and remain till January, when they drop off and new ones begin to grow. The males are great fighters, and sometimes two of them get their horns so locked together that they cannot get them apart again, and die of starvation. The flesh of the common deer is tender and juicy, and of good flavor.

The **American Elk** is much like the red deer of Europe, but is larger, being nearly as large as a horse. It is chestnut-red in summer and grayish in winter. Its horns are the

Head of American Elk.

finest of all the deer's horns, being five or six feet long and having many branches, as shown in the picture. A set of these horns have been found which were so long that when standing on their tips a tall man could walk through them without touching. The elk of Europe has large spreading flat horns.

The word elk is from the Celtic *elch* or *elg*. Julius Cæsar, who first wrote about the elk, called it *alces*.

The **Moose** is the largest of all the deer family, being equal in size to a heavy horse. It has very long legs and a large, ugly head with long, broad antlers. It is grayish-brown, and its hair is coarse. The moose is an awkward animal, but can run very fast. It is still common in the wild parts of Maine and Northern New York, and thence upward to the frozen regions. In the winter the moose keeps on the wooded hillsides, living on tender shoots and the bark of trees, being very fond of birch and poplar. In the spring it

Head of Moose.

comes down to the rivers and lakes, and may often be seen standing in the water to get rid of the flies and gnats. Its antlers are shed every year, usually in December; they begin to grow again about the 1st of April, and are full grown in June or July. The flesh of the moose is coarse, but is much liked by many.

The word moose is from the Indian name of the animal, which was *mongsoa* or *moosoa*.

The **Caribou**, or **American Reindeer**, is found in Maine, New Brunswick, and westward as far as Lake Superior. It is thought by some to be the same as the reindeer of Lapland. It is considerably larger than the common deer, is deep brown in summer and grayish in winter, and, unlike other deer, both males and females have horns. In winter it lives mostly in swamps, feeding on mosses and lichens, but in spring it goes up the hillsides and lives on buds and twigs. Far in the North herds of more than a hundred of them are sometimes seen. The caribou is very fleet, and not easily tired. Hunters have sometimes followed one more than a week without being able to get a shot at it. The flesh is tender and of good flavor. The skin when dressed makes the best clothing for very cold countries. It is said that a person wearing a suit of caribou leather and having a blanket of the same can sleep warmly on the snow even in the great cold of an Arctic winter's night. It is thought that the caribou may be tamed and made as useful as the REINDEER of Lapland.

The deer is one of the most useful of the wild animals. Its flesh, which is called venison, is excellent for food; its tanned skin, commonly called buckskin, is valuable for many uses; its sinews furnish the Indians with bow-strings and cords for many other purposes; and its horns are made into handles for cutlery. The parings of deer's horn were formerly made into hartshorn or AMMONIA.

The deer is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word deer comes from the Anglo-Saxon word *deor*, which once meant any small wild animal.

DEMIJOHN, a kind of large glass bottle covered with wicker-work. The glass part is blown, like any other BOTTLE, and the wicker-work, which is usually of willow or osier, is then woven around it in the same way that a BASKET is made. Demijohns are very useful because, on account of their strength, they can be made much larger than bottles. Acids are commonly put up in large demijohns called carboys.

The word demijohn is from the

French *dame-jeane*, Lady Jane. In Egypt a demijohn is called *damagan*, which is said to be from Damaghan, a town in Persia, once noted for its glasswork.

DERRICK. See CRANE.

DEW. A certain amount of heat is necessary to keep the watery vapor in the AIR from condensing, that is, from changing back again into water; and the lowest degree of heat at which it will remain in the air as vapor is called the dew-point. While the heat is above or at the dew-point the vapor will stay in the air; but if the heat falls below the dew-point the vapor will be condensed and will fall to the earth as dew or RAIN.

The earth, which gets its heat directly from the sun itself, and not from the air, which the sun does not heat, is always radiating, that is giving off its heat; and not only the earth, but all things on it, especially all kinds of plants, are all the time radiating heat, so that at night, when there is no sun to give them more heat, their surfaces become cold. When air which is full of vapor touches these cold surfaces the part of it next to them is cooled below the dew-point and its vapor is condensed on them in the form of dew. The moisture which collects on the outside of a pitcher of ice-water in a warm room is an example of this. There is more dew on a fine clear night than on a cloudy night, because when there are no clouds the heat given off by the earth passes into space, or the upper air, and is lost, and the earth becomes cold enough to condense the vapor into dew; but when there are clouds they stop the heat from going off into the upper air, and the earth does not become cold enough to condense the vapor. An awning or a tree will keep the dew from forming under them, not because it stops the dew from falling, but because it prevents the heat from rising from the earth, so that it does not become cold enough to condense the vapor in the air which touches it. Grass and the leaves of plants radiate heat very freely, and so receive more dew, which is necessary for them, than polished metals, smooth stones, and woollen cloth, which do not need dew. If polished metal collected dew as easily as grass, it would be very hard to keep it from rusting; and if woollen cloth collected it readily, our clothes would be often wet at night. See FROST.

The word dew comes from the Anglo-Saxon *deaw*.

DIAMOND. The diamond is the purest form of CARBON, and is valuable on account of its rarity and brightness. It is the hardest of all known things, is not hurt by ACIDS or ALKALIES, and may be heated red hot without injury; but it may be burned in OXYGEN gas, or even in the open air if the heat be very great.

Diamonds are found in earth mixed with gravel. When first dug up they are usually covered with a yellow or reddish crust. When this is taken off their brightness is seen, but they are generally of a bad shape and have to be cut before they are fit to set in jewelry. Most diamonds are without color and as clear as water; but sometimes, on account of other things mixed with them, they are white, gray, yellow, brown, or green, and more rarely red, blue, and black. Diamonds perfectly free of color are said to be of the first water and are most valued. Those of a slight rose tint are valued highly, and next to these green tinted stones are considered the best. Black diamonds are also very rare, but those which are slightly brown or tinged with the other colors are least valuable. The largest and finest diamonds are brought from India, chiefly from the Golconda mines, but many fine ones are found in Borneo, Brazil, and South Africa. The South African diamond mines

on the Orange and the Vaal rivers are now the most productive in the world. In 1867 a teamster saw a pretty pebble among a lot of stones on a boer's table. The boer gave it to him, and it proved to be a diamond worth twenty-five hundred dollars. The search for more then began, and in 1869 the mines were discovered and soon became famous for their production. Diamonds have been found in the United States in North Carolina, Georgia, Virginia, and California, but no very large ones.

Diamond Cutting is very slow and tiresome work, and sometimes many months are needed to make a very large stone fit for setting in jewelry. The parts of the stone not needed in shaping it are first split off, for though the diamond is very hard it may easily be split. The stone is fixed in a little ball of CEMENT, and the piece to be taken off is marked by scratching round it with another diamond; it is then easily split off by putting the blunt edge of a knife in the cut and striking the back of the knife with a little hammer. The pieces thus chipped off are called "bort." They are used for grinding down other diamonds and gems, by glaziers for cutting glass, by watchmakers for drilling holes in rubies and other hard stones for the works of watches, and by gem engravers for cutting stones; and some, when large enough, are cut into small stones for jewelry. After the waste parts of the stone have been split off, it is then ready to be cut. To cut a diamond means to grind its surface so that it shall be covered with the little flat faces, or facets, as they are called, which are seen in all diamonds set in jewelry. The stone is fastened in a ball of cement on the end of a stick and rubbed with another diamond set in the same way on the end of another stick. The workman rests the stick on the edge of a little box, and the dust, called diamond powder, which is rubbed off, falls through the fine holes in the bottom of the box and is saved to polish with. In this way each facet is worn down little by little. When all have been thus cut and the stone is in the shape wanted, it is given to the polisher, who

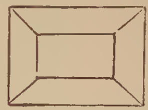


Fig. 1.—Table-cut Diamond—Top View.

fastens it with soft solder into a copper cup at the end of a stout wire, and holds it against a small steel wheel, wet with oil mixed with diamond powder, which is made to turn round very fast. By this means the facets are polished one by one, the stone being set in new solder for

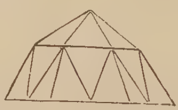


Fig. 2.—Rose-cut Diamond—Side View.

grinding each facet. Polishing takes much more time than cutting.

Diamonds may be cut into various forms, called the table-cut (Fig. 1), the rose-cut (Fig. 2), and the brilliant (Fig. 3). Most stones now used in jewelry are made into brilliants, because brilliant-cut stones

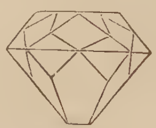


Fig. 3.—Brilliant-cut Diamond—Side View.

have many more facets than the other kinds, and the LIGHT is therefore reflected and refracted more times. This makes more rainbow tints in it, and therefore gives it greater beauty. Diamonds waste much in cutting, some stones losing more than one-half their weight.

The **Orloff Diamond,** named from Count Orloff, who bought it in 1772 for the Empress Catherine of Russia, is the largest cut diamond in the world which is known to be a true diamond. It was once the eye of an idol in India. A Frenchman, who happened to see it, made a glass one like it and, watching his chances, put it in the place of the diamond, with which he ran away. He sold it to the captain of a ship for $10,000, and the captain took it to Europe and sold it for $100,000. At last it came into the hands of a diamond merchant, who sold it to Count Orloff for $450,000 in money and a yearly payment during his life of $20,000. The empress also made the merchant a noble. This stone, which is rose-cut, is shaped like half a pigeon's egg, and weighs 194¾ carats (see PRECIOUS STONES). Its size and shape are shown in the picture.

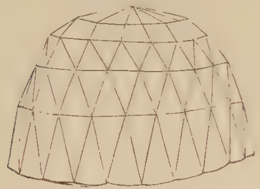


Fig. 4.—Orloff Diamond—Side View.

The **Pitt** or **Regent Diamond,** which is the next largest one, gets its first name from Mr. Pitt, governer of Madras, India, who bought it, in 1702, for $100,000. Its other name comes from the Regent Duke of Orleans, to whom Mr. Pitt sold it, in 1717, for Louis XV., for $650,000, but it is said to be worth twice that sum. It is thought to be the most perfect brilliant-cut diamond in the world. It weighed at first 410 carats, but Mr. Pitt had it cut, and its weight is now 136⅞ carats.

The **Florentine** or **Grand Duke Diamond,** a fine yellow stone, rose-cut, belonging to the Emperor of Austria, is the third one in size. This is one of three great diamonds lost by Charles the Bold at the battle of Granson (1476). A Swiss soldier found it, and thinking it to be a piece of rock crystal, sold it for a few pennies. It weighs 133⅛ carats.

Fig. 5.—Star of the South as found.

The **Star of the South,** the fourth great diamond in the world, was found by a negro in Brazil in 1853. It weighed 254½ carats when found, and only 124¼ carats when cut. The pictures show its shape and size before and after cutting, Fig. 5 being the rough stone, as it was found, and Figs. 6 and 7 being side and top views of the stone as it now is.

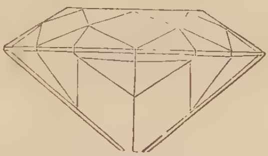


Fig. 6.—Star of the South as cut—Side View.

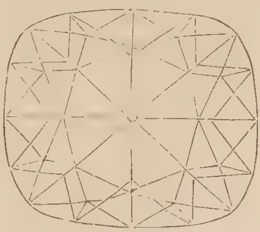


Fig. 7.—Star of the South as cut—Top View.

The **Koh-i-noor** (Mountain of Light), now owned by the Queen

of Great Britain, is the fifth one in size. When this stone was found, in Golconda, India, several hundred years ago, it weighed $793\frac{5}{8}$ carats. An Indian prince, who owned it, got

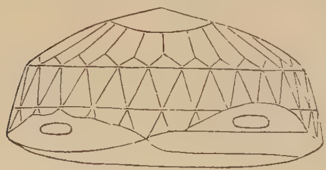


Fig. 8.—Koh-i-noor, First Cutting—Side View.

an Italian to cut it for him, and he did it so badly that he lowered its weight to about 186 carats. In 1850 it came into the hands of Queen Victoria. It has since been cut to a rose form, and now weighs only $106\frac{1}{16}$ carats. Figs. 8 and 9 show side and top views of the Koh-i-noor as first cut, and Figs. 10 and 11 side and top

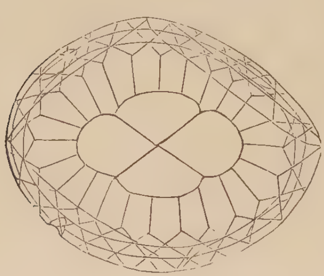


Fig. 9.—Koh-i-noor, First Cutting—Top View.

views after the last cutting. There is a very large stone, called the Braganza, among the crown jewels of Portugal, which weighs 1880 carats. The Portuguese say it is a diamond, but it is generally thought to be only a topaz. Another very large stone, said to be a real diamond, is owned by the Rajah of Mattan, in Borneo, where it was found in 1760. It is about as large as a small hen's egg, is shaped like a pear, and weighs 367 carats. This is probably the largest uncut diamond known. A diamond weighing $288\frac{3}{8}$ carats was found in South Africa in 1873, but it is not a very fine stone and is full of flaws.

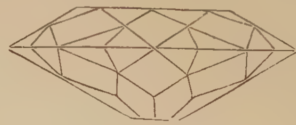


Fig. 10.—Koh-i-noor, Second Cutting—Side View.

It is called the Stewart diamond. The King of Portugal is said to have a diamond of 138 carats, and the Sultan of Turkey one of 148 carats, but not much is known about them.

The word diamond is from the old English *diamant*, which came from the Latin and Greek *adamas*, meaning unconquerable; and the stone was so called because it cannot be cut by any other substance.

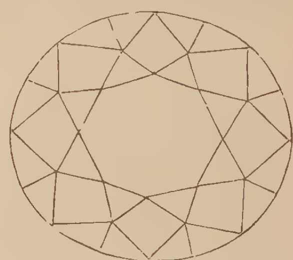


Fig. 11.—Koh-i-noor, Second Cutting—Top View.

DIE, the metal stamp with which the devices, or figures, are stamped on coins, medals, etc. Dies for coining or stamping are always made of the finest steel. The engraving of them is called die-sinking, and the engraver a die-sinker. There are always two dies for each coin or medal, one called the die for stamping the obverse or upper side, and the other, called the counter-die, for stamping the reverse or under side.

In making a die a piece of steel is cut off from the end of a bar, made into the right shape, and strengthened by putting an iron ring around it.

After the face has been made smooth, the steel is softened by heating it in the fire and cooling it very slowly, and the die-sinker then engraves on it the figures wanted. This is very difficult, each letter and figure having to be cut out little by little by means of small and very hard steel tools. This takes weeks, and sometimes months, of patient and careful labor. The die thus made, which is called the matrix, is just the opposite of a coin, all the parts which are raised on the coin being sunk below the surface in the die. Figures cut below or into a surface are said to be in *intaglio* (Italian *intagliare*, to cut in); and when raised above the surface they are said to be in relief (Italian *rilievo*, raised work.)

The die is now hardened by heating it red hot and cooling it suddenly in water, and is then ready to be used for coining. But the first die, or matrix, is generally used only for making other dies. By carefully driving into it a round piece of soft steel of the right size, an exact copy of the matrix is made on it, only that the figures are raised above the surface instead of sunk below it. This new piece, which is called a punch or puncheon, is now hardened, and by driving it in the same way into other pieces of softened steel exact copies of the matrix may be made; and these last ones are used in coining money, after the date has been cut in the right place.

Dies for coining money are not cut so deep as those for making medals, because coins in too high relief would wear out too soon and too much pressure would be needed in the coining press to stamp each piece, making it therefore cost too much. Dies are used also for striking out metal buttons, ornaments for harnesses, and a great number of other metal manufactures, but they are not so carefully made as those for coining.

Another class of dies is used in stamping figures on paper, cloth, leather, and other soft things. Book covers are stamped with such dies, which are cut in brass instead of in steel. All kinds of raised figures and ornaments, whether plain, printed in colors, or gilded, are put on to book covers, portfolio covers, and other such things, by means of brass dies, some of which take much time and skill to make.

The word die is in French *dé*.

DIME, a silver coin of the United States, worth ten cents. It was first coined in 1796.

The word dime is from the French *dixieme*, a tenth, from the Latin *decem*, ten.

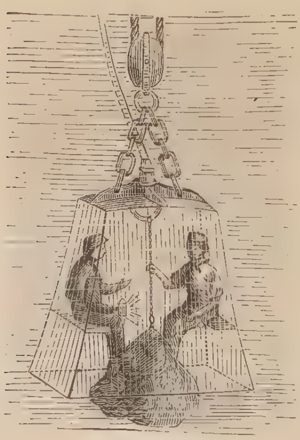
DISTAFF, the staff for holding the flax or wool from which the thread is drawn in spinning by hand on the common spinning-wheel. It is not much used now, as thread for weaving is mostly made by machinery. The distaff is a very ancient instrument and is often put into pictures as an emblem of woman; hence in poetry it is sometimes used to mean woman or the female sex.

The word distaff is from the Anglo-Saxon *distæf*.

DIVING-BELL, a hollow vessel, sometimes bell shaped, in which a person may go down under water and work. The way in which it works may be seen by pressing a tumbler down bottom upward into water. The air in it, having no way of getting out, keeps the water out; but as AIR is compressible, it is pressed up into a smaller space, and if the tumbler were pushed down thirty-three feet under water the air in it would fill just half the space it did at the surface. It is just the same in the diving-bell, and the person who goes down in one has to breathe this closely packed air. If he had no more air to breathe than that which is in the bell, he could stay under water only a few minutes, so fresh air is pumped into it through a tube, which leads into the top of the bell. If this pipe were open

all the time, the air would rush up through it out of the bell, and the water would rise up and fill the bell and perhaps drown the man in it. This is prevented by having a little VALVE, or small door, which opens inward only. The air which is pumped down through the tube is thicker than that in the bell, and the valve is therefore pushed open and the air forced in. As soon as the AIR-PUMP stops working, the air in the bell shuts the valve and keeps it tight until more air is pumped down. But the pump is usually kept working while anyone is in the bell, so as to keep the air pure. If too much air is forced in, it comes out of the open bottom of the bell and flows up to the top of the water in great bubbles.

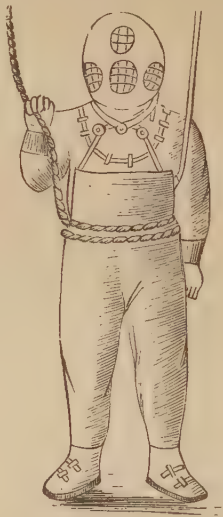
The diving-bell is commonly made of cast iron, so that it will sink by its own weight and will be strong enough to resist the pressure of the water, which is very great. It has seats for its workmen, and is hung



Diving Bell.

by chains to a CRANE which is sometimes on shore and sometimes in a vessel. Men above work the air pumps and answer the signals of those in the bell.

Diving Armor is sometimes used instead of a diving-bell. This is made up of a copper hemlet large enough for the head of a man to move about in freely, and which has



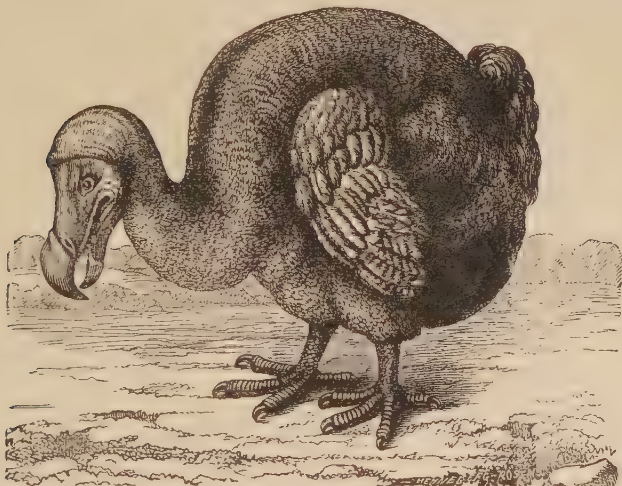
Diving Armor.

several thick glass windows in it, so that he can see in all directions; a copper breast-plate, to which the helmet is fastened; and an India-rubber dress, which covers all the lower part of the body. When the diver has this on, he can go under water without getting at all wet. Before going down he puts on shoes with heavy lead soles, which make him sink easily to the bottom and help him to stand up in the water. He is then let down by a rope tied round his waist, and air is pumped down to him through a tube. This diving armor is now much used in laying stone foundations under water and in raising sunken vessels. It is also used by coràl, sponge, and pearl divers, in some places.

DOCK, a basin for ships in a harbor or river, where they may load or unload or be repaired. In the United States a wharf is wrongly

called a dock; the dock is rightly the space or slip between two piers, and not the pier itself. There are several kinds of docks, but they may all be divided into wet docks in which ships lie to load or unload their cargoes, and dry docks, where they are hauled out of the water for repairs.

In this country the rise and fall of the tide is so small that our docks are usually only open slips; but in England the difference is so great between high and low tide that vessels in slips like ours would sometimes be far above the pier and sometimes a good way below it. This would be very unhandy in taking goods in or out, and so docks are built with gates which keep the water always about the same height. At high tide, when the water outside the dock is as high as that inside, the gate is opened and ships pass out and in; but as soon as the tide begins to fall the gate is closed and the water in the dock, which would run out with the tide, is thus kept always high. Most of the English docks are made with locks (see CANAL), so that by wasting a little of the water in the dock vessels may be let in or out at any tide. The Atlantic Dock at Brooklyn is properly a basin and not a dock, because it has no gates and the tide flows in and out of it.



Dodo. (See page 224.)

Dry Docks, sometimes called graving docks, because they are used for graving or cleaning the bottoms of ships, are of two kinds. One kind is solidly built of water-tight masonry and fitted with a gate which is closed after the vessel has been floated into it, and the water is then pumped out, leaving the vessel dry. Another kind, sometimes called a floating dock, is built of timber and planks, or of iron and planks, and is so made that by letting water into its air-tight boxes it may be sunk deep enough to float a vessel on to it; the water is then pumped out of the boxes and they fill with air, which raises the dock up with the vessel on it. As the dock is open at both ends, all the water runs out of it as it comes up, and the vessel is thus left dry. Some docks, called screw docks, are fitted with a frame

into which the vessel is floated, and the frame with the vessel on it is then raised up by means of screws.

The word dock is in German *docke*, and is perhaps from the Italian *doccia*, a mill-dam.

DODO, a kind of pigeon (see page 223), larger than a swan, that used to live in the island of Mauritius. Dodos were first seen by Vasco de Gama in 1497; they are mentioned by many writers down to about the middle of the seventeenth century, when they became extinct. In 1644 the Dutch began to colonize the island, and the few dodos then left were soon killed, most of them by dogs, cats, and rats that ate the eggs and the young birds in the nest. Though the dodo was a gigantic pigeon, it was clumsy and could not fly; it had only a bunch of curled feathers for wings, and a similar bunch on the rump. It had a large bill and stout scaly legs. It lived chiefly on fruits, built its nest of grass and sticks on the ground, and laid but one egg.

The word dodo is from the Portuguese *dondo*, a simpleton, a fool.

DOG. The monuments of Egypt show that many kinds of dogs existed in the most ancient times, and that the dog was in the earliest ages the friend and companion of man, as he has been ever since. The Egyptian dog lived in the house of his master, followed him when he went out, and lay under his chair when he took his meals, to receive the bones and other

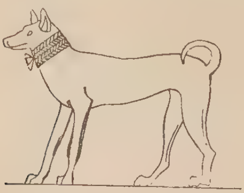


Fig. 1.—Egyptian Hunting Dog.

bits thrown from the table. This custom of feeding dogs at table was practised by all the ancients, even by the Greeks and Romans, whose ideas of delicacy differed somewhat from ours. Egyptian dogs had slaves to take care of them, and they were washed, combed, and decorated

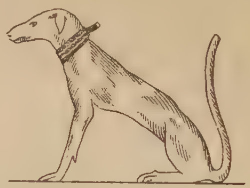


Fig. 2.—Egyptian Hound.

with collars just as pet dogs are to-day. In Fig. 1 is shown the picture of one of the hunting dogs of King Antef of the eleventh dynasty, about 3300 B. C., who loved his dogs so

Fig. 3.—Dog Mummies.

well that he had them engraved on his monument. Fig. 2 is the portrait of a hunting hound from the tomb at Thebes of Anna, of the eighteenth dynasty. The Egyptians made a god of the dog and gave their god Anubis a dog's head. They had also dog cemeteries, just as they had cat cemeteries, in which mummied dogs were preserved. They were swathed in cloths much like human mummies, and had pasteboard heads painted brown, with white around the eyes, mouth, and ears, as shown in Fig. 3.

Origin of the Dog. Some think that all wild dogs were once tame, and others think that all dogs, both

wild and tame, are descendants of wolves. The prairie wolf and the coyote of the West are wild dogs, and it is supposed that the Indian dogs came from them. In the West Indies and South America are many wild dogs, supposed to be the descendants of dogs carried there by the Spaniards. They hunt in bands, and do much harm to flocks and to the young of cattle and horses.

The common or tame dog differs much in size, form, color, and character. The German boar hound, used for hunting the wild boar, is nearly four feet high at the shoulder, while some of the smaller kinds are only a few inches high. The hair of some dogs is long, fine, and shaggy, of others short and coarse, and there is a breed in India which has its skin entirely bare. Some have small sharp ears which stand up, and others have long, large, hanging ears. In some the feet are webbed, fitted for swimming; in others the feet and legs are made for running swiftly.

The young of dogs, called puppies, are born with their eyes shut, and do not get them open until they are ten days old. Dogs are full grown when they are two years old, and they live generally about fifteen years. Young dogs are apt to have a disease called the distemper, which comes on usually when they are getting their teeth. It lasts generally twenty to forty days, and about half the dogs born die of it. They also have sometimes a dreadful disease called hydrophobia, a word made of two Greek words, *udor*, water, and *phobos*, fear, in which they show great fear of water, and will not touch it even when thirsty. A dog with this disease has red eyes and no appetite, and is dull and cross, and after a while is seized with madness, and runs here and there, biting at whatever comes in its way. It is very dangerous at this time, because whatever it bites is apt to have the same disease, and it should be at once killed.

The **Esquimaux Dog,** so called because it is much used by the Esquimau Indians of Greenland and the northern parts of America, is nearly

Fig. 4.—Head of Esquimaux Dog.

the same as the Siberian dog. It has shaggy black and white hair, a bushy tail, a sharp nose, and small pointed ears which stand up as in the picture. It is bold, fierce, and strong, is a good swimmer, and loves to play and burrow in the snow. This dog is not only the friend and companion of its master, but is also his beast of burden, and will drag him for hours at a time at great speed on his sled. In Greenland these dogs are harnessed several abreast, or in a row sidewise,

Fig. 5.—Head of Spitz Dog.

but in Siberia they are harnessed in pairs, one pair ahead of the other. Ten or twelve dogs are often hitched to a sled, and they are guided wholly by the voice of their master.

The **Spitz Dog** is a variety or kind of the Esquimaux dog, and is much like it, as will be seen in the picture, but is a little smaller. It is a very pretty and bright dog, but is apt to be snappish and is hardly a safe pet for children. It is usually white or black. Its home is in Pomerania, on the coast of the Baltic Sea.

The **Newfoundland Dog,** found in the island of Newfoundland and in Labrador, is larger than the Esquimaux dog, and is generally black, or

Fig. 6.—Head of Newfoundland Dog.

black and white, through there are some yellow ones. It is handsome, has long curly hair, a bushy tail, large hanging ears, and bright eyes. It is very strong, is intelligent, kind and trusty, and is one of the best of water dogs. Many stories are told of the brightness of Newfoundland dogs, and many children, and even grown people, have been saved from drowning by them.

A gentleman who was spending the summer at a seaside watering-place in Ireland, was accustomed to walk in the evening along the quay with a fine Newfoundland dog. The dog delighted to play in the water, and his master often sent him in to fetch things, to the great amusement of the people who gathered on the quay to see him swim and dive. Captain, for this was the dog's name, soon became a great pet, and every-one used to watch eagerly for his coming. One day another gentleman, a major in the army, came, bringing with him two bull-dogs of great size and strength. On the first day the new dogs took no notice of Captain, who swam and dived in his usual way; but on the second evening, when he was following his master along the quay, one of the brutes flew at him and caught him by the neck, and though Captain fought bravely, the bull-dog came off victor, and could not be made to give up his hold until his jaws were forced open with an iron bar. Poor Captain went home limping and bleeding, and did not come to the water side again for several days; and when he did appear he looked much crestfallen and stuck close to his master's heels, with his tail between his legs. One evening about ten days after the fight, the major and his bull-dogs stopped close by the edge of the quay to look at something in the water. Captain, who was just then passing with his master, saw that his time had come, and springing with all his strength upon his conqueror, caught him by the back of the neck and jumped with him into the sea. The bull-dog could do but little in the water, for Captain kept his head under all the time. The people were glad to see the bull-dog punished and would not give him any aid. The major shouted: "My dog! my beautiful dog! will no one save him?" But no one stirred. At last, seeing that his dog was drowning, he called out: I will give fifty pounds ($250) to any one who will save my dog!" Then some men went out in a boat and rescued the bull-dog, which was so nearly drowned that it was with great difficulty brought to itself again. Captain swam in triumph to the shore, amid the shouts of the people, who rejoiced with him in his victory over the ugly brute.

The **Saint Bernard Dog** is much like the Newfoundland in looks, as will be seen from the picture (Fig. 7.) These dogs get their name from the

monastery of Saint Bernard, in the Alps, between Switzerland and Savoy. The monastery is on the highest part of the road across the mountains, 8000 feet above the sea, and is the highest house in Europe. Here monks live with their dogs all the year round, and do a great deal of good by saving the lives of travellers lost in the snow. After a snow storm these dogs go out, carrying food, wine, and clothing strapped to them, and search for lost people. When they find anyone buried in the snow-drifts they dig him out, and bark for the monks to come and help them. Many lives have been saved in this way. It is

Fig. 7.—Head of Saint Bernard Dog.

said by some that the old breed of dogs kept at Saint Bernard have all died out, and that the dogs now kept there are yellow short-haired ones with very large feet.

The **Greyhound** does not belong among the true hounds, though it is much like them in some things. It hunts game by sight, and not by scent or smell, like other hounds. It has a very long body and neck, and long slim legs, so that it stands quite high. Its nose is also very long and slim as shown in Fig. 8. This dog is thought to have come from western Asia and some of the largest ones are still to be found in Persia and Tartary. These greyhounds have long shaggy hair, but the large English greyhound, and the Italian greyhound, which is small and very slender and much kept as a pet by ladies, are smooth haired.

Among the true hounds are the bloodhound, the staghound, the fox-

Fig. 8.—Head of Greyhound.

hound, the pointer, the setter, and the spaniel. The **Bloodhound** is a large strong dog, which was much used in olden times in England in hunting and in chasing criminals, and even enemies in war. It does not follow by sight, but merely by the sense of smell, and gets its name because it will follow a wounded animal by the scent of its blood spilled on the earth. It will also smell the footsteps of an animal or a man, and chase it, even if other animals have gone along the same

Fig. 9.—Head of Bloodhound.

path. In the times of the wars between England and Scotland, bloodhounds, or sleuth-hounds, as they were called, from the Scotch word

sleuth, meaning the track or trail of a deer, were much used in chasing cattle-stealers and other thieves on the borders. The Buccleuch family kept many of the breed, and Sir Walter Scott, in his "Lay of the Last Minstrel," tells how the young heir of Buccleuch was lost in the wood,

> "Until he heard the mountains round
> Ring to the baying of a hound,
> And hark! and hark! the deep-mouthed bark
> Comes nigher still, and nigher;
> Bursts on the path a dark bloodhound,
> His tawny muzzle tracked the ground,
> And his red eye shot fire."

We also read in the chase of Fitz James, told so well in the "Lady of the Lake," how

> "Two dogs of black St. Hubert's breed
> Unmatched for courage, breath, and speed
> Fast on his flying traces came,
> And all but won the desperate game:
> For scarce a spear's length from his haunch,
> Vindictive toiled the bloodhound staunch."

These famous black bloodhounds called St. Hubert's, are supposed to have been brought by pilgrims from the Holy Land. Another larger breed, also called St. Hubert's, but more highly prized than the black ones, were pure white. Still another kind was reddish gray. The bloodhounds of the present day are probably a mixture of all these breeds.

When a bloodhound was chasing a man, the only way to stop him was to pour blood on the track; for the hound was confused by the fresh smell and would no longer follow the old scent. In the old times, when soldiers were closely followed by a hound, a prisoner was sometimes killed to throw the dog off the scent. It is said that Wallace, when forced to retreat with only sixteen men after a battle, killed a man to escape from his enemies, who were following him with a bloodhound. When the dog reached the body and smelled the fresh blood, he would go no further. Bloodhounds were used by Henry VIII. in the wars in France, by Queen Elizabeth against the Irish, and by the Spaniards in Mexico and Peru.

The true bloodhound has long hanging ears. The dog called bloodhound in Cuba, formerly much used

Fig. 10.—Head of Cuban Bloodhound.

in tracking runaway slaves, is not a real bloodhound, and is probably a descendant of the mastiff, crossed perhaps with the bull-dog. Its ears, as will be seen in Fig. 10, are pointed and stand up, as in the mastiff and the bull-dog

The **Staghound**, the noble animal kept in old times for hunting deer, is part bloodhound and part greyhound. It is a little smaller than

Fig. 11.—Head of Staghound.

the real bloodhound, and, like it, has hanging ears, as shown in Fig. 11. The staghound is the dog so often painted by Sir Edwin Landseer.

It is not now very common, but long ago, when stag hunting was a royal sport, the staghound was the companion of nobles and always had his place by the hall fire. Sir Walter Scott makes the minstrel sing of Branksome Hall:

"The tables were drawn, it was idlesse all;
Knight, and page, and household squire,
Loitered through the lofty hall,
Or crowded round the ample fire:
The staghounds, weary with the chase,
Lay stretched upon the rushy floor,
And urged, in dreams, the forest race,
From Teviot-stone to Eskdale-moor."

The modern English **Foxhound** is thought to be only a smaller kind of staghound, the only difference between them being that the one is trained to hunt the fox and the other the stag.

The **Pointer** gets its name from its habit of stopping and pointing

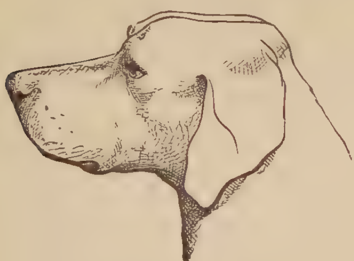


Fig. 12.—Head of Pointer.

with its nose at game. This is very useful to the hunter when looking for birds in tall grass. As soon as the dog smells a bird, he stands still, holding his breath, and pointing at the game. If the bird run, he creeps after it slowly and carefully, always keeping his eye on it, and stopping now and then for fear he shall start it up too soon; and he takes great delight when at last the bird is shot and he sees it at his master's feet. The pointer is short haired, and has a head much like that of the hound, with long hanging ears, as in Fig. 12.

The **Setter** gets its name from a like habit, only it crouches instead of stands when pointing at game. It is thought to be part pointer and part spaniel, as its figure is something

Fig. 13.—Head of Setter.

between the two. Its hair is long and silky, not so smooth as that of the pointer, but wavy like that of the spaniel. The setter is a better water dog than the pointer.

The **Spaniel** is supposed to have first come from Spain, from which it gets its name. It is a very old breed, and was well known to the Romans. The form of the spaniel is much like that of the setter, but the body is smaller. Its fur is long, silky, and curly, and its ears are large and hanging. It loves the water, has a strong scent, and makes

Fig. 14.—Head of Spaniel.

a fine hunting dog. There is a kind called the water spaniel, much used in hunting ducks. Some spaniels are very small, especially those called King Charles spaniels, from Charles

I., who loved to keep these little dogs about him.

The **Mastiff** is a very large dog, with a broad head, and strong neck and limbs. Fig. 15 gives a very

Fig. 15.—Head of Mastiff.

good idea of the mastiff's face. This kind of dog lived in England before Cæsar invaded the island (55 B. C.). It was much prized by the Romans on account of its great courage, and was used by them in the sports of the circus, being matched to fight with different wild animals, sometimes even with the lion. Alexander the Great brought mastiffs to Greece

Fig. 16.—Head of Bull-Dog.

with him, when he came back from India. These are supposed to have been the great mastiffs of Thibet, which are the fiercest of their kind.

The **Bull-Dog** is supposed to be a smaller kind of mastiff. It is more solidly formed than the mastiff, and has a broader and thicker head. The ears are commonly cut pointed, and made to stand up, as shown in Fig. 16, but droop a little when not clipped. The bull-dog came from England, and it is so called because it was once much used in bull-fighting.

The **Bull Terrier** is a small kind of bull-dog, probably a cross between the bull-dog and the terrier. It is more lively than the bull-dog, and takes great delight in rat hunting.

The **Terrier** gets its name from its following game into burrows in the

Fig. 17.—Head of English Terrier.

earth (Latin *terra*). It is a sleek, bright little dog, with a fine form, long legs, a sharp eye and ear, and a quick sense of smell. Its color is usually black, with tan colored legs, and a tan colored spot over each eye. It is sometimes called the English terrier, or simply the black and tan terrier.

The **Scotch Terrier** is a little fuller in the face, with a stouter body and shorter legs, and is covered with shaggy wiry hair. It is usually of a sandy yellow, but is sometimes nearly white. Its ears stand up, and its hearing, smell, and sight are very sharp. The Skye Terrier, so called from the island of Skye, one of the Hebrides, where it is raised, is much

like the Scotch terrier, but uglier, its face being almost covered with hair. Terriers are much used in hunting, for driving foxes and other game out of their holes, and also for rat killing.

The Scotch terrier, though not handsome, is very quick and bright, as the following story will show. A gentleman of London had a farm, about sixty miles from the city where he kept a large mastiff and a Scotch terrier. On going to the city once for the winter he took with him the terrier, who travelled with the servants in a carriage. On arriving in London the terrier was put into the stable, where a large Newfoundland dog was kept as a watch dog. This big fellow, who seemed to look upon himself as master there, did not show any pleasure at the sight of the little dog, and after a few days gave him a sound thrashing. The terrier, who seemed to be much grieved at this unfriendly treatment, crept away into a corner of the stable and kept very quiet through the night. The next morning he was missing, and though search was made he could not be found anywhere, and he was given up for lost. But on the third morning after his disappearance he came into the stable, followed, to everybody's surprise, by his old friend the big mastiff from the farm. This great fellow at once flew at the Newfoundland dog and gave him a terrible beating, while the little terrier sat by and looked on with the greatest pleasure. As soon as the mastiff had revenged the wrongs of his little friend, he trotted out of the stable and was seen there no more. It was afterward found out that the terrier had gone back to the farm and brought the mastiff up to London to whip the town bully, and that the mastiff, after avenging his old friend, had returned home again to the farm.

Another terrier, named Rory, used to despise lap-dogs, and took great delight in frightening them. One day he saw a fat old lady with a very fat lap-dog waddling along behind her. He trotted along beside it, looking at it for a little while, and then gave it a pat and rolled it over on its back. The old lady screamed and snatched up her pet and put it on her muff, when Rory walked along on his hind legs, which he had been taught to do, and kept snapping at the little dog, to her great terror. She struck at him with her boa or

Fig. 18.—Head of Scotch Terrier.

fur tippet, but Rory caught it in his mouth and ran off with it down the street, wild with delight, every now and then rolling over it heels over head.

The **Poodle** (German *pudel*) dog first came from Germany, but is now common in all countries. It is a water dog, is very bright, and may be taught many smart tricks. An English gentleman was once crossing one of the bridges over the Seine in Paris, when he felt something run against his feet, and looking down he saw that a small poodle had covered his boots with mud. He was very angry, but the dog ran away, and the gentleman, when he had crossed over the bridge, had his boots cleaned at a boot-black's stand. Some days after he had to cross the bridge again, and the same thing happened. Thinking that this was odd, he stopped and watched the dog for a while. He saw him

rub against several gentlemen's feet till he had got off all the mud from his shaggy coat, then run down to the river bank and roll himself till his fur was filled again. With his new supply he ran back to the bridge and daubed the feet of the passers-by as before. After a time, instead of going back to the river, he ran across the bridge to the boot-black, who petted him as if he knew him well. The gentleman then saw that the poodle had been trained by the boot-black to dirty people's feet so as to make more work for him; and he was so much pleased with the brightness of the little fellow that he paid his master a large price for him and carried him to England with him. He took him into the country about forty miles from the seaside, but the dog had been there only a few days when he disappeared. Search was made and rewards were offered for him, but he was not found. Several weeks afterward the gentleman got a letter from a friend in Paris telling him that the little poodle was back there again busy at his old trade of soiling boots. The little fellow, not liking the dulness of country life had gone down to the seaside, and, as the gentleman afterward found out, had got on board of a steamer which landed him at Boulogne, and from there he had made his way back to his old master in Paris.

The **Shepherd Dog,** so called because used to watch sheep and to protect them from other animals, looks somewhat like a wolf. Its nose is longer and sharper than that of the spaniel, and its ears are pointed and standing. Notwithstanding its looks, it is faithful and true, and takes the best of care of the sheep given into its keeping. It drives them to and from the pasture, never allowing any strange sheep to get mixed up with them, and never losing any, searching them out even during the great snow storms so frequent in the Highlands of Scotland. In countries where there are wolves, it guards the flock while feeding, and keeps them together much better than the shepherd himself could do. Many of these dogs are now used in California, where sometimes one may see thousands of sheep without any shepherd, watched only by half a dozen faithful dogs.

The largest kind of sheep dog stands about fifteen inches high, but the purest and most intelligent kind, the Scottish collie, is seldom more than twelve to fourteen inches high at the shoulder. The collie is greatly loved by his master, and when at home is the pet of the household.

In France and in Germany dogs, principally shepherd dogs and wolf dogs, are now trained for use in war, to search for the wounded on the field of battle. The dogs remain by the wounded and howl until aid comes. They are found very useful in this duty, especially at night, when they easily find men who would have been overlooked by the assistants.

The dog is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the dog family, to which belong also the fox, the wolf, and the jackal.

The word dog probably comes from the Danish and Swedish *dogge*. In the Icelandic language it is *doggr*.

DOLL. Children have always played with dolls, and it is probable that they made them of rolled-up rags in the most ancient times, just as they make them to-day. Dolls of baked clay, of wood, and of other things have been found in Egypt in tombs, where they had lain buried since before the time of Christ. One of these is shown in the picture.

Dolls are now much more carefully made than they were in former times, and a great deal of skill is needed in their manufacture. Most of those sold in the stores come from Germany and France. In the little town of Sonneberg, in Germany, hundreds of thousands of dolls and wooden

toys are made every year. Most of the dolls are made out of PAPIER MACHÉ; but many fine ones are made with wax or china heads, and a great many cheap ones are made out of wood. Papier maché, wax, and china heads are all made in the same way. All dolls of the same size which have like faces are made in one mould; and there have to be as many moulds as there are different kinds of faces. In making a doll, the first thing is to get a model, or figure, of the exact size and shape of the head, for a pattern. This is made by a skilful workman called the modeller. The modeller sets a lump of soft clay on his table, the top of which turns round and can be raised up or lowered as he wishes it, and carves and shapes it into the form of a doll's head, making the face as perfect as he can. When done it is dried hard, and it then goes to another workman called the moulder. The moulder lays the model, face upward, in a dish of wet clay, and packs more wet clay round it until one half the model is covered. He then builds a wall of clay round it, some inches higher than the face, so that when done the whole looks like a box half full of wet clay, with a doll's face sticking out at the bottom. Enough melted sulphur is then poured into the box to cover the face. When this cools it becomes hard and makes a mould of the doll's face. The clay is next taken away, the model turned over, and a mould of the back of the head is made in the same way. Thus a mould of the whole head and shoulders is made in two parts, one forming the face and the other the back of the head.

Egyptian Doll.

The moulds now go to another room where a workman is rolling out papier maché, or paper pulp made into a kind of dough, into loaves like bread. The pulp has a little clay mixed with it to make it stiffer, and a little glue to make it more sticky. Another workman rolls it into sheets a little thicker than pie-crust, cuts it into pieces of the right size, and piles them up with some powdered clay between to keep them from sticking together. Still another workman takes these pieces, one at a time, and fits them into the moulds, pressing them in with his fingers, and then passes them to a man next to him, who with a kind of tool fits them carefully into every part. After the edges have been pared off evenly with a knife, each half mould is taken out and dried. The two parts are then glued together, and thus the whole doll's head is made of stiff paper.

It now looks much like common gray pasteboard, and has no eyes and no hair. The eye-setter first cuts off the top of the head with a sharp knife, and then cuts a hole for each eye. In common dolls the eyes are merely glued in, but in the better kind of dolls, which open and shut their eyes, the eyes are hung on a bent wire with a piece of lead at the end, the weight of which causes them to move when the doll is moved. A piece of cork is put in for the lead to hit against, and some plaster and pieces of wood to strengthen the head, and the top which was cut off is then glued on again.

After the bits of glue and any other rough things have been smoothed off, the doll goes to the waxer, who dips it head foremost into a kettle of boiling white beeswax. Cheap dolls are dipped but once, but fine ones get several coats of wax. The head next goes to the painting room, where one workman paints it all over with flesh color, another paints the lips, a third the eyebrows, a fourth the cheeks, and a fifth the eyelashes. But some

dolls have eyebrows and eyelashes of real hair.

The next thing is to put on the hair. Some dolls have real hair made like a wig with lace under it which is glued on to the head. It is then dressed like a live person's hair. But in many the hair is made of wool, which is braided up tight and boiled to make it stay wavy. China and wood dolls have their hair only painted.

The bodies of dolls are made of cloth or leather, and are commonly stuffed with sawdust, but in dolls that cry they are stuffed with hay, because the sawdust would be apt to get into the crying part and stop it up. The crying is made by a kind of bellows, which works when pressed by the fingers, like that which makes a toy cat mew. The hands and feet are made in the same way as the head, and all are glued on to the body. The last thing is the dressing. Cheap dolls have only a single dress made by a sewing machine, but the better kind of dolls are dressed in fashionable clothes by dolls dressmakers, who make a business of it. It takes thirty or forty different persons to make a single doll, as each one does only one thing; but many more can be made in a day in this way than if each workman made a whole doll.

China dolls are made in the same way as those of papier maché, only the dough pressed into the moulds is china clay instead of paper pulp. There are also real wax dolls, whose heads are all wax, and whose hairs are fastened in one by one instead of being glued on. Some are made to say "papa" and "mamma," when different strings are pulled. Such dolls have very beautiful wardrobes and are very expensive, often costing several hundred dollars apiece. Common wooden jointed dolls are made mostly in Germany, by poor people who whittle them out by hand.

Dolls used by East Indian children are very different from any in this country. They are all made of wood painted with different colors, and are all like the one in the picture. They differ only in size, some being not more than six inches high, and some as tall as a small boy. Each doll has a baby in its arms and is fixed to a wooden block so that it can stand up. Its clothes are only painted wood, its arms are not jointed, and the only thing which can be taken off is the head, which is fastened into the body by a peg.


East Indian Doll.

In Japan children have every year what is called a "feast of dolls." This is held only on one day of the year, at which time all the dolls that have belonged to the family are brought out from the safe places where they are usually kept, and put upon tables with many kinds of playthings. Sometimes there are more than a hundred dolls, some of which are dark with age, for often dolls two hundred years old are shown at this feast. They are dressed in all sorts of ways, some like mikados and tycoons, as the old rulers of Japan were called, some like court ladies and gentlemen, and some like common ladies and gentlemen. Some of these dolls are very small, and some as large as a little girl. Though the feast of dolls lasts only one day, the toys are shown for several days, and are then put away until the next year.

Talking Dolls. These toys, invented by Edison, are dolls with a kind of PHONOGRAPH inside. The doll looks like any other doll, but its body is made of tin to hold certain machinery which works like a real phonograph, but is made much cheaper. Girls are employed to

talk into the mouth-pieces of these phonographs whatever words the doll is wanted to speak—such as "Mary had a little lamb," "Jack and Jill," etc. The phonograph is then put into the body of the doll, which is fitted with a crank behind, and on turning this at any time the doll will speak the words or verses taught it in the factory.

The word doll is probably short for Dolly, which is diminutive for Dorothy.

DOLLAR, the money unit or standard of value of the United States. It contains 100 cents or 10 dimes, and is made in gold and silver coins and in notes. The silver dollar was coined first in 1794. It was made of the value of the Spanish milled dollar, so called from its milled edge, called also the pillar dollar from the figure on its reverse of the Pillars of Hercules, the ancient name of the two promontories on opposite sides of the Straits of Gibraltar. The dollar mark ($), is said to have been taken from this design. In 1849 gold dollars were first coined. In 1873 a lighter dollar, called a "trade dollar," was issued for use in commerce with China and Japan.

The word dollar is of German origin, being now spelled *thaler* in Germany. It is short for Joachimsthaler, meaning a silver piece coined at Joachimsthal or Joachim's dale, in Bohemia. It was sometimes called also Schlickenthaler, because coined by the Counts of Schlick.

DOLPHIN, a MAMMAL of the same family with the whale and the porpoise. The common dolphin found in most of the seas of the world is 6 to 10 feet long, with a long narrow snout and jaws fitted with teeth. It is dark on the back, gray on the sides, and white underneath. Though shaped like a fish and living always in the water, the dolphin is not a fish but a warm-blooded air-breathing mammal which suckles its young. Like the whale, it comes to the surface to breathe, and like it also, it swims chiefly by means of its tail, its fins being used to balance it in the water. It is very swift, its speed excelling the fastest steamer. Schools of dolphins often follow ships by the hour sporting around the bows, leaping out of the water, and apparently chasing each other over the waves. The dolphin lives principally on fish, which it catches and holds with its teeth, and swallows whole. Its flesh is dark colored and

Common Dolphin.

of good taste, and is often eaten by sailors on long voyages. In old times it was considered a delicacy, and in the sixeenth century it was so high in price as to be found only on the tables of the rich, but it is not now generally eaten.

The dolphin is sometimes called, from the shape of its beak, the goose of the sea. It was considered sacred by the ancients and was dedicated to Apollo, whose most famous oracle at Delphi was named after it. It was a dolphin, too, that saved Arion (C. P. P., ARION) when he was thrown overboard by the sailors on his voyage from Italy to Corinth. The dolphin was an emblem on the coat-of-arms of the princes of France, and from it was named the province of Dauphiny, which gave the title of dauphin to the heir to the throne.

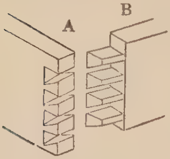
The dolphin is a MAMMAL of the order *cetacea*, and of the same family with the PORPOISE.

The word dolphin comes to us

from the French *dauphin*, Latin *delphinus*, a dolphin.

DOME, the rounded cover or roof of a building. The Italians call the principal church in a town *duomo*, because the churches in Italy were once almost all covered with domes, and the name was in time given to both the building and its roof. The Germans also still call a cathedral church a *dom*. Some architects give the name of dome to the outside or convex part of the roof, and call the inside or concave part the cupola; but with others the words cupola and dome are used to mean the same thing. The Romans were the first to put domes on buildings, and that on the Pantheon in Rome is still the finest and largest one in the world, it being 142 feet in diameter or width. The next largest dome in the world is that of the reading-room of the British Museum (140 feet), and after that come those of the Duomo in Florence and St. Peter's in Rome (each nearly 139 feet), that of St. Sophia in Constantinople (115 feet), and that of the Capitol in Washington (nearly 95 feet).

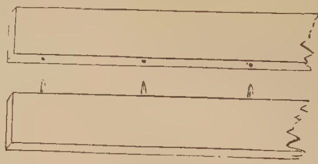
DOVETAIL, a kind of joint for fastening boards tightly to each other, used in making boxes, bureau drawers, etc. The end of one board is cut like A in the picture, and the other is cut like B, so that the one will fit into the other. If you look at a bureau drawer, you will see how this is. If the boards were only nailed together they might pull apart, but when fastened with this joint they cannot be drawn apart. Such a joint is sometimes used instead of the MORTISE and tenon joint, to join one beam to another, but not very often.



Dovetails.

The dovetail gets its name from its shape, which is like that of a dove's tail spread out.

DOWEL, a pin of wood or metal used for joining two pieces of wood, stone, etc., together. Parts thus fastened are said to be dowelled, and the joint thus made is called a dowel-joint. The heads of barrels and casks are usually dowelled, as shown in the picture. Metal dowels are used in stonework, to keep cut stones in place.


Dowels.

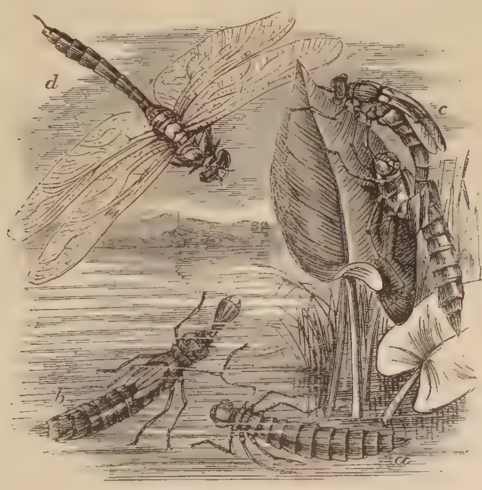
The word dowel is perhaps from the French *douelle*, a socket or hole for a peg or pin.

DOWN, the fine soft feathers of birds, especially on the breasts of water birds, such as the duck, goose, and swan. The best down is got from the nests of the EIDER DUCK. Some is taken from the breasts of birds which have been killed; this is called dead down and is not so good as nest down, which live birds pull off with their bills from their own breasts, and is therefore called live down. Down is so soft that a great deal of it can be packed in a small space. It is sent from the countries where it is got, in balls about as large as a man's fist, each weighing three or four pounds; but it is so elastic or springy that when one of these balls is spread out and warmed over hot coals it will swell up into enough to fill a bed large enough for two persons. But eider down is used generally only to stuff bed-quilts with, and not to sleep upon, as it easily becomes matted together. What is called gray down or white down comes from common geese, and not from eider ducks.

The English word down comes from the Icelandic word *dunn*, which means the same.

DRAGON-FLY. This insect is easily known by its large head and chest, its four great wings, and its long slender abdomen, which tapers out behind much like a darning-needle, and from which it is commonly called "devil's darning-needle." But it is not worthy of so bad a name, as it is entirely harmless, and never bites nor stings. It is also called the mosquito hawk, because it lives mostly on mosquitoes, of which it kills and eats great numbers. It also eats flies and other insects, and is therefore of great service to us, and ought to be welcomed instead of driven away. Its prey is always caught on the wing, by means of its claws, and not with its mouth.

Dragon-flies pass through three stages or changes in life, two in the water, and one in the air. The eggs are laid in little bunches on the leaves and stems of water plants, just under the surface of the water. The larva, or insect, when first hatched from the egg, is brownish, and has six legs. The one in the



Changes of the Dragon-Fly.

a, Larva; *b*, Pupa; *c*, Perfect Insect coming out of Pupa-case; *d*, Full-grown Dragon-fly.

picture, marked *a*, is full grown. The pupa, or second stage, is shown in *b*, where can be seen the jaws or nippers with which insects and even small fish are caught. These nippers are fastened to a movable stem, and when not in use can be folded over the face so as to partly cover it. For this reason it is called a "mask." When an insect comes near, the nippers can be quickly stretched out to seize it and carry it to its mouth. The young of the dragon-fly live nearly a year in the water, where they breathe as fishes do, only the breathing place is at the end of the tail instead of at the head. They creep along on the bottom and also move through the water by spirting water out from behind, which pushes them along just as the stream of fire from the end of a rocket forces it up into the air.

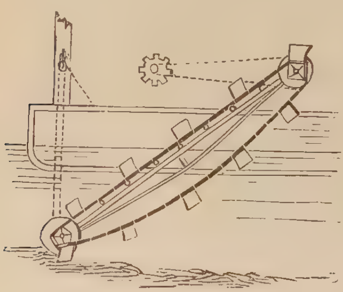
When the time comes for the dragon-fly to enter upon the third stage, the pupa crawls up out of the water and fastens itself to the stem of some water plant. The skin

which covers it then splits along the back, and the full-formed winged insect creeps slowly out, as shown in *c*. The wings soon dry, and in about an hour the dragon-fly, *d*, mounts into the air, where it passes a merry life of a few short weeks. Tennyson describes this last change very prettily :

> "To-day I saw the dragon-fly
> Come from the wells where he did lie.
>
> An inner impulse rent the veil
> Of his old husk ; from head to tail
> Came out clear plates of sapphire mail.
>
> He dried his wings ; like gauze they grew ;
> Thro' crofts and pastures wet with dew,
> A living flash of light he flew."

The dragon-fly belongs to the order *neuroptera*, or membrane-winged INSECTS.

DREDGE. Rivers and harbors are apt to become clogged up with mud, sand, and gravel, brought in by the tides and currents. As these



Dredging Machine.

fill the channels and make it hard for large vessels to enter them, means have to be taken to clear them out. Different kinds of scoops or buckets have been used for digging up and raising the mud, but the dredge or dredging machine most used now is a kind of frame, which may be raised or lowered through a long box made in the middle of a scow. In the picture the front half of the scow is shown cut away so that the working of the dredge can be seen. At each end of the frame is a roller, around which an endless chain is made to work, and on this chain are fastened many iron scoops. One end of the frame is let down into the water through the bottom of the scow until it touches the mud. The endless chain is then made to turn round the rollers by means of a steam engine, and the scoops scoop up the mud. As each scoop is filled, it comes up on the chain, dumps its load, and then passes down on the under side of the rollers to bring up more mud. Thus the scoops come up one after the other without stopping, each bringing its load and dumping it, and thus raising a great deal of mud in a short time. The mud falls into a trough, through which it runs into another scow placed alongside the dredge.

Another kind of dredge is made like two scoops with teeth on the edges. When let down into deep water, it settles into the mud and sand, the teeth shut together, and it is then raised up, bringing in it stones, shells, gravel, and mud. The dredge is then swung round by means of a CRANE until it is over the scow, when the teeth open and let the load fall out. A small dredge, made in nearly the same way, and worked sometimes by hand and sometimes by steam, is used to gather oysters from their beds.

Scientific men use instruments called dredges to raise from the bottom of the ocean animals and plants whose habits they wish to study. These are not like harbor dredges, but are small scrapers fitted with nets and other things to catch whatever they touch when dragged over the bottom. Such dredges are also very useful in laying ocean telegraphs, for by means of them it can be found whether the bottom is fit for the cable to lie on.

The word dredge is probably made from drag.

DRILL, a tool used for boring holes in metals and other hard substances, such as horn, bone, ivory,

etc. There are many forms and sizes of drills. They are usually made of steel wire or of steel rods, flattened and pointed at the end used for cutting, but some have a cutting edge like an awl. Drills are

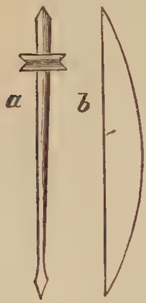


Fig. 1.—Watchmaker's Drill.

Fig. 2.—Drill Stock.

used something like augers, but most of them turn only halfway round in the hole and then back again, cutting both ways. They are made to turn in several ways. The drill used by watchmakers (Fig. 1) is worked with a bow. The drill, *a*, has a little pulley near the upper end, and the bow, *b*, which is made of whalebone, has a fine catgut or horse-hair string. This string is twisted once round the pulley when the drill is to be used. The upper end of the drill is then set into a little hole made in the watchmaker's vice for that purpose, and the lower end, or cutting point, is set against the work to be drilled, which he holds in his left hand. By moving the bow to and fro, the drill is made to turn around quickly, first one way and then the other, and a hole is thus cut little by little into the metal. For larger drills a steel or strong wooden bow, with a catgut string, is used; or sometimes they are turned by rubbing them with a flat stick covered with Indian-rubber. Such drills are held against the chest, the workman having a flat steel breastplate, in which the upper end is put. He can thus lean on the drill and keep it steady, while both hands are free to work.

In Fig. 2 is shown another kind of drill handle, or drill stock, as it is called. The upper end, which turns round, is held against the chest, and the drill is worked by moving up and down the nut or ferrule, *c*, which works on the screw and causes it to turn. All these drills are for light work. A third kind of drill is shown in Fig. 3. It is called the pump-drill, because it is worked up and down. It has a shaft or spindle, in the bottom of which the drill is fastened by a screw. Near the lower end of the shaft is a wheel, but some have a round ball instead. The cross-bar, which has a hole in it and works up and down the shaft, is fastened at each end to a string, the middle of which is fastened at the top of the shaft. The string is twisted round the shaft, as shown in

Fig. 3.—Pump Drill.

the picture. As the hand moves the cross-bar down it unwinds the string, and this turns the shaft round; as the cross-bar is moved up again the wheel keeps on turning and winds

up the string again, so on. This kind of drill is used by china menders to drill holes in china and glass. A drill working in the same way, but having a stone instead of a steel point, was used by the people of the South Sea and Samoan Islands for drilling holes in their fish hooks, which were made out of shell. The Iroquois and some other North American Indians used a like instrument for making FIRE.

In Fig. 4 is shown the common smith's brace, used much by blacksmiths. The handle, *e*, is turned round by the hand of the workman, and the drill, *f*, is kept pressed tightly on to the piece of metal, *g*, into which the hole is to be drilled, by turning the screw, *a*, at the top. Besides these, there are machines for drilling, some of which are worked by hand and some by steam power. As there is much rubbing or friction in drilling metals, both the work to be drilled and the drill itself would get very hot if they were not kept moist. In drilling most metals oil, or soap and water is used, but gold and silver are sometimes kept wet with milk. Very hard steel and hard stones are drilled by means of copper or soft iron drills used with emery powder and oil. Drills fitted with diamond points are also used with oil for drilling very hard steel.

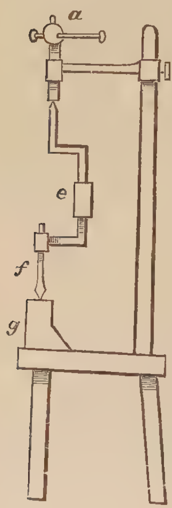


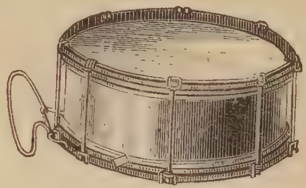
Fig. 4.—Smith's Brace.

The word drill comes from the Anglo-Saxon *thyrel*, a hole.

DROMEDARY. See CAMEL.

DRUM, a musical instrument played by beating. Drums are usually made of thin wood or brass, and covered at one or both ends with skin. Two kinds are used in military bands, the snare drum and the bass drum.

The **Snare Drum,** which is sometimes called the side drum because the drummer wears it hanging by his side, gets its name from the snares or strings stretched across its lower end. These, which are usually of CATGUT, tremble when the drum is beaten on the upper end, and add to its sound. The long wooden snare drum is now giving place to a shorter kind made of brass, like the one shown in the picture, which is the drum used in the German army.


German Snare Drum.

The **Bass Drum** is beaten on both ends, and is much larger and makes a deeper sound than the snare drum. It is used chiefly in military bands.

The **Kettle Drum** is made of thin copper or brass, and is shaped like a kettle or basin. It is covered over the top with skin, and generally stands on a tripod, or three-legged stand, as shown in the picture. It is used chiefly in ORCHESTRAS, though small ones are sometimes carried by bands on horseback, like those of cavalry regiments. Two kettle drums are generally played in orchestras, one of which is tuned with the other instruments, and the other a little higher.

All kinds of drums have long been used among Eastern nations, and the instrument is supposed to have been first brought into Europe

by the Moors. The negro races in Africa have a great love for the drum, and have many different kinds and sizes. In Dahomey drums are made from the trunk of a tree called the benteria, hollowed out with hatchets and with burning irons. The head is covered with a goat skin fastened with wooden pins and stretched tight by a cord. They have small drums used in travelling, at the sound of which people quicken their steps, and several kinds for use in the army. Another kind, used in merrymakings, has a peculiar charm for the negroes, who are seized with a desire to dance whenever they hear it. The *gbaydoo* is a very large drum kept in the courtyard of the palace, and beaten when war is declared. All know its sound, and when it is heard the soldiers come together in a hurry

Kettle Drum.

To capture a gbaydoo from an enemy is like capturing a flag among civilized nations.

The word drum was probably named from its sound. In Old English the word was spelled *drumme*. In old Saxon *drom* meant a noise.

DUCK. Ducks have broader bills and shorter necks than geese and swans, and their legs are much shorter and set further back than those of geese, so that they walk with a more waddling gait. Their food, too, is mostly animal, while that of geese and swans is chiefly vegetable, and the males differ more from the females than is the case with swans and geese.

There are two classes of wild ducks, those which live in shallow inland waters and rivers, and those which live mostly in the ocean and seldom go up rivers. These two kinds differ in many ways, the first class, which fly the most, having longer wings and necks than the second, whose legs are better fitted for swimming. Among the most common ones of the first kind found along the Atlantic coast of the United States are the black duck, the mallard, the teal, and the widgeon. To the second class belong the old wife, the velvet and the surf duck (both of which are wrongly called coot), the red-head, and the canvas back.

The **Canvas Back,** which is the most prized of all water fowl, is found only in North America. It gets its name from its white back, most of its other parts being dusky red, black, or slate color. The canvas backs shot in Chesapeake Bay are the best, on account of the food they get there, the root of a water plant commonly, but wrongly, called wild celery. The ducks dive down to the bottom, pull up the roots and come up to eat them, throwing away the stalks, with which the top of the water is strewn. This root gives their flesh a fine flavor, and such ducks sell much higher than any others.

Other wild ducks feed mostly on insects, worms, snails and other MOLLUSKS, and small fish. Many kinds of both inland and sea ducks spend the summer in the Arctic regions and go south in the winter. Wild ducks always live in pairs, but tame ducks do not.

The common domestic or tame duck is descended from a wild duck belonging to the inland kinds, called the mallard. Among the best of the tame kinds is the Aylesbury duck, which is very large and prized for its fine flesh. The Muscovy, more properly musk duck, is so called because it has an odor of musk about it. It also is very large, and has a red lump or carbuncle at the upper end of the bill. It is supposed to have first come from South America. There are more ducks in China than in any other country on the globe; they are seen everywhere, around villages, in the streets of cities, and on canals, lakes, and rivers. Ducks are sold in the markets fresh, salted, and smoked, and duck's eggs are an important article of food. The Chinese hatch great numbers of eggs in hot sand, and bring up the young ducks by hand.

The duck belongs to the order *natatores*, or swimming BIRDS, and to the same family with the goose and the swan.

It gets its name from its habit of ducking its head under water.

DYES. The dyeing or coloring of cloth is an art which takes a great deal of knowledge and skill. If a piece of cotton, woollen, or silk cloth be dipped into some kinds of dyes and then dried it will be stained the color of the dye so that it cannot be washed out; but this is not true of all dyes. Some need something else mixed with them to fix the color, and others have to have the cloth prepared before it is put into the dye. It is the dyer's business to know these things, and to do so he has to learn all about the different drugs and other substances used for dyes, and the nature of the materials out of which cloths are made.

Most of the dyes in use come from plants. The coloring matter is got sometimes from the roots, sometimes from the stems and bark, and sometimes from the flowers and seeds. Among the most important vegetable dyes are BRAZIL WOOD, LOGWOOD, MADDER, SAFFLOWER, FUSTIC, ANNOTTO, quercitron or yellow oak bark, TURMERIC, INDIGO, SUMAC, ALDER, BARBERRY root, and red SANDAL or sanders wood. A few dyes, such as COCHINEAL and LAC, come from animals; and a great many substances used in dyeing are got from the metals and other minerals. Some of the most beautiful colors are made out of the coal tar of gas works. These are usually called aniline colors (Arabic *an-nil*, the indigo plant) because they are made from aniline, which is got out of coal tar. Aniline is a kind of oily liquid, which is colorless when pure; but when it is mixed with different things may be made into a great number of beautiful colors. Red, yellow, green, blue, and black dyes, of many different shades, are thus made out of dirty coal tar, which used to be thrown away as of no value. Among the aniline colors are those called magenta, solferino, roseine, mauve, azuline, emeraldine, bleu de Paris, and Bismarck.

Besides the dyes, there are other substances used in dyeing which fasten the colors to the threads of the cloth. These are called mordants (French *mordant*, biting, from Latin *mordere*, to bite), because they bite the colors into the cloth so that they cannot be washed out. The principal mordants are ALUM, the SALTS of ALUMINUM, tin, and iron, and SODA. By the use of different mordants different colors are got from the same dye. Thus, madder will give a rose tint with one mordant, dark red with another, dark brown with a third, and black with a fourth.

Some colors are made by many dyeings in different liquids, some of which change the tint and some of which fix them to the cloth.

In dyeing cloths they are soaked in tubs holding the dyes, then passed through squeezers and drying

machines to get all the dampness out of the threads, and lastly through finishing machines which give them a smooth surface. Generally cotton and linen are harder to dye than wool and silk; and when cloths are made of different things, such as mixed goods of cotton and wool, or of wool and silk, they have to pass through several dyes, some of which dye the cotton, some the wool, and some the silk. In some mixed goods one of the fibres is of one shade of color and one of another, because the dye which dyes one will not dye the other.

The word dye comes from the Anglo-Saxon *deag*, a dye, a color.

E

EAGLE. The eagle has a curved beak, broad wings, legs feathered down to the toes, and strong, sharp, curved claws. Its food consists of birds, small quadrupeds, and sometimes fish. When hungry it will kill animals as large as sheep and pigs. The eagle is found in nearly all parts of the world. It lives mostly in wild mountainous regions, and builds its nest on high cliffs out of reach of man and its other enemies.

The **Golden Eagle,** which is found all over Europe and America, is among the largest of the eagles. It is not often seen in the Eastern States, but is common in the Northwest. Its color is dark brown, but the back of the head, the neck, and the lower tail feathers are brownish yellow, from which it gets its name. It is said to live more than a hundred years. The Indians use its feathers to adorn their heads, pipes, and weapons with. Its nest is built of sticks, usually on some high cliff, and it lays two dull white eggs shaded with brown.

Head of Golden Eagle.

The golden eagle carries off many lambs, kids, and other small animals to its nest, during the breeding season, to feed its young, and it has even been known to seize and fly away with a baby. In Scotland two children were once stolen by eagles in one season, but fortunately the theft was seen and both were safely rescued by men who climbed up to the nests. In Switzerland, where eagles build their nests on high mountain crags, babies have been thus carried off and eaten, and only their bones left. Once, during a famine in Ireland, a poor man got food every day for his family by watching an eagle's nest, and taking from it part of the animals which the old birds brought to feed their young with. When the young ones grew old enough to fly, he clipped their wings so that they could not leave the nest, and thus kept the old ones bringing food much longer than they would otherwise have done.

The **Bald,** or **White-headed Eagle,** as it ought to be called, as its head is feathered like all the eagles, is the one used as the emblem of the United States. It is found almost all over North America. The bald eagle belongs to the fishing or sea eagles, and its usual food is fish, which it steals from the FISH HAWK. When a fish hawk is seen to catch a fish and start for the shore, the eagle pursues and forces it to drop it, and then swoops down and catches the fish before it reaches earth. Like the golden eagle, the bald eagle lives to a great age. Its plumage is dark brown, with head, neck, and tail white. It builds its nest usually on high trees, and lays two dull white eggs.

The **Harpy Eagle,** the most powerful bird of prey of America, belongs in South and Central America and Mexico, but is sometimes seen in

Texas and in Southern California. Its body is ashy-gray barred with black, head and under parts dull white, and feet yellowish. It measures six or seven feet across its outstretched wings and about three feet from the head to the base of the tail. Its beak is curved and so strong that it can crush a man's finger bones, and its stout feathered legs are armed with claws sharp and powerful as those of a wild cat. It can overtake in flight the swiftest birds, and it attacks and kills young fawns, full grown foxes and badgers, and even monkeys. The harpy eagle, if taken young, can be tamed, and it is a common pet in farmhouses in Mexico. The Incas of Peru and the Aztec nobles used to train harpies to hunt, just as falcons were trained in Europe. Cortez was presented by a Mexican prince with a hunting eagle, called *el hidalgo del aire*, the "prince of the air," of which he became very fond. He used to prick the bird with his dagger when it did not await his signal to attack, and once, when it flew up before he told it to, he got angry and fired a pistol ball after it. The shot broke the eagle's head and it came tumbling down to the ground in the agony of death. Cortez ran to it and kneeled down to see if he could not save his pet, but it was too late. The harpy tried to rise to its feet several times, then lay still; but before it died it seized the forefinger of its cruel master's right hand in its beak and crushed it, and so avenged itself.

The eagle was the emblem of imperial Rome, and is now the emblem of the Austrian and Russian empires and of the United States. The Austrian and Russian eagles are made with two heads, in imitation of the double-headed eagle first used by Constantine the Great, one of the heads of which meant the Western Empire, and the other the Eastern Empire.

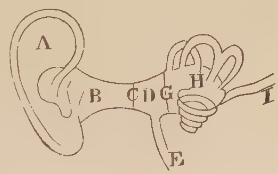
The eagle belongs to the order *raptores*, or BIRDS of prey, and to the falcon family.

The word eagle is from the Latin *aquila*, eagle, which is the feminine form of *aquilus*, dark-colored or brown.

EAGLE, a gold coin of the United States worth ten dollars. It was first coined in 1795. The half-eagle was first made in the same year, the quarter-eagle in 1796, and the double-eagle in 1849. These coins are not pure gold (see ALLOY).

The eagle was named from the emblem of the United States, the bald EAGLE.

EAR. In the article SOUND it is told that there is no such thing as sound outside of the ear, but that what we commonly call sound is carried in a series of waves to the ear, inside of which there is certain machinery which makes us hear. The ear is made up of three different parts, which may be easily un-



Plan of the Human Ear.

derstood by the picture. This picture is not exactly like the ear, but is only a diagram, or plan, to show how it works. The first part is made up of the outside ear, A, and the pipe, B, which leads inward. The outside part of the ear is much like the open part of wind instruments, or of a speaking trumpet, and serves to gather the sound waves and turn them into the pipe, B. This pipe, which is a little more than an inch long, is stopped by a skin, C, which is stretched tightly across it. Behind this skin, which is called the membrane or skin of the drum (Latin, *membrana tympani*), is the second or middle chamber of the

ear, D, called the drum (Latin *tympanum*), which is filled with air by a pipe, E, opening into the mouth. The drum is hollowed out of the bone of the skull, and its inner opening, called the oval window, is closed by another skin, G. Beyond this is the third or inner chamber of the ear, H, which has in it little canals and a winding passage like that of a snail shell. This inner chamber is filled with a watery fluid, in which floats the acoustic or hearing nerve made up of a bundle of fine cords. These cords are gathered into one nerve, I, which leads to the brain.

When sound waves are collected by the outer ear, they pass through the pipe B, and striking upon the skin of the drum, C, cause that to vibrate or quiver with exactly the same kind of motion. These vibrations or quiverings are carried through the middle chamber, D, to the second skin, G, stretched over the oval window. From this they go to the liquid which fills the inner ear, and the acoustic nerve, floating in this, gathers them up and carries them to the brain.

Within the drum (D) of the ear is a chain of four little bones, too small to be shown in the picture, which reach from the middle of the skin (C) of the drum to the skin (G) of the oval window. These carry the sound waves from the first to the second skin. One of them, named the lenticular bone, because it is shaped somewhat like a LENS, is the smallest bone in the body. The three others are called, also from their shape, the hammer, the anvil and the stirrup. Of these the hammer is fastened to the skin of the drum and the stirrup to the skin of the oval window. The air in the drum of the ear also helps to carry the sound waves, but its principal use is to make equal the pressure of the atmosphere on the skin of the drum. If there were no air inside, the outside AIR would press too heavily on this skin.

The larger the outside ear is, the more are the waves of sound which are caught. Therefore, some animals which have very large ears hear much better than man does. We could hear better if our ears were larger. Sometimes, when we do not hear very well, we put up our hand to our ear, and this helps us by stopping and turning into the ear more sound waves. Deaf people use an ear trumpet, which answers the same purpose. Timid animals, such as the rabbit, the hare, and the deer, have large ears which they can move, so that they can hear in every direction. The horse, too, can move its ears backward and forward, so as to hear what is coming ahead and behind. This makes it a more useful animal, for it is quick to hear the commands of its master. Some persons can move their ears in this way, and all can learn to do it.

The ear is guarded from injury by being so placed that its inner parts are inclosed in the hardest bone of the body. The outer part, which is open, might be harmed by insects crawling into it, but it too is guarded by the wax. This is very bitter, and there is probably something in the smell of it which insects do not like. If one by chance goes into the ear, it soons becomes covered with the sticky wax, and dies after a while, if it is not taken out. If an insect causes pain in the ear, a little sweet oil should be poured in and left there until it is smothered. The wax sometimes becomes hard, but if left to itself it will generally dry and scale off. In no case should it be picked out with any sharp instrument, as deafness may be caused by it. The skin of the drum is easily pierced, and if thus injured much pain and trouble may come from it. If the ear needs cleansing, it should be done by syringing it with warm water.

The word ear is from the Anglo-Saxon *eare*, which comes from the Latin *auris*, ear.

EARTH. The earth appears to us to have a nearly flat surface, broken here and there by hills and valleys, and stretching out on all sides until it meets the sky; but we know that it is not flat because ships sail round it. If a ship start from a place and keep sailing westward, it will in time come to the same place from the east side. We cannot tell the exact shape of the earth from this, because if it were square a ship could sail round it in the same way. But we know from watching ships on the sea that the earth is not square but rounded. When a ship is coming toward us from a distance only the masts are seen, and they appear to grow taller and taller until at last the hull comes into view; and when a ship sails away from us, the hull first goes out of sight and then the masts little by little until all is gone. If the sea were flat, ships would grow smaller and smaller as they sailed further away, and would finally disappear altogether; and if the earth were square, they would go out of sight all at once, when they reached the edge; but we see that they go out of sight little by little, first the lower parts and lastly the tops of the masts, and we know from this that the earth is neither flat nor square, but rounded. We can prove, too, that it is round like a ball, because in eclipses of the MOON the earth, which then comes between the sun and the moon, casts a round shadow on the moon, just such a shadow as one globe would cast on another globe. We know also that it is very large, because we can see vessels for many miles before they go down out of sight. The earth is, indeed, a great ball which measures nearly 8000 miles (7912) in a line through its centre.

Day and Night. The earth hangs in space just as a balloon does in the air, because on whatever part of it we go we can always see the heavens above us, and it is all the time spinning round like a great top. If we look, on any clear night, at the eastern horizon (Greek, from *horos*, a boundary), or place where the earth and sky meet, we shall see some stars rising up above the edge of the earth, while those in the western horizon will be going down below the edge of the earth. We can see the moon too rising in the east and setting in the west, and in the daytime the sun follows the same course. These look like real movements, and the ancients believed that the earth stood still and that the heavenly bodies travelled round it; but the sun and the stars do not really move, but only appear to move from east to west because the earth is all the time turning round from west to east. The eastern edge of the earth goes down as the western edge rises, and thus the sun and stars first come into sight in the east and are shut out of view in the west. As there are about twenty-four hours between each sunrise or coming of the sun on the eastern edge of the world, we know that it takes the earth just that time to turn round once. This causes day and night, for we call it day when the part of the earth on which we are spins round into the sunlight, and night when it has turned so far around as to hide the sun from us. As the sun is fixed in the heavens, the earth must turn round, for if the earth too were fixed, the side of it toward the sun would always be bright, and the side from the sun would always be dark. But as all sides of the earth have their night and their day, we know that the earth must turn round.

The Seasons. The spinning round of the earth like a top explains many of the motions of the other heavenly bodies, but not all of them, and we are therefore led to think that it has some other kind of motion. Indeed, we know from many things that the earth rolls round the sun in a great circle called an orbit (see UNIVERSE), travelling round it once in

$365\frac{1}{4}$ days, and this movement makes our year, just as the other movement, which we have likened to the spinning of a top, makes our day. Now if the earth spun round exactly like a top, standing straight up and down, and moved round the sun in that way, the days would always be of the same length all over the world, and the seasons would never change. But in summer the days are much longer than in winter, and when it is summer here it is winter on the other side of the earth; we therefore know that the motion must be in some other way.

These things can be best shown by means of a lamp and an orange. Set a lamp in the middle of a round table in a dark room. Let the lamp stand for the sun and the edge of the table for the orbit or path in which the earth travels round the sun. Then stick a knitting-needle through the middle of an orange, to stand for the earth; set it upright in a pin-cushion, as shown in the picture, Fig. 1, and place the pin-cushion near the edge of the table. Twist the needle so as to make the orange turn round in a way different from that in which the hands of a watch move. You will see, as the orange turns round, that there are two points on it, which do not move out of their places, one at the top and one at the bottom, where the knitting-needle goes through. These points

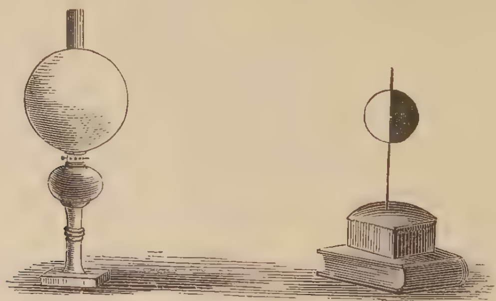


Fig. 1.—Lamp and Orange, or the Sun and Earth.

are called the poles, the one at the top being named the north pole, and the one at the bottom the south pole. The line joining the two poles, and upon which the orange moves, is called the axis. In the orange the knitting-needle is the axis, but in the earth there is no real axis, we only imagine one for the earth to turn round on. Now draw a circle round the middle of the orange, everywhere at the same distance from each of the poles, so as to divide it into two equal parts, and call it the equator (Latin *æquare*, to make equal). The part north of the equator is usually called the northern hemisphere (half globe, from Greek *hemi*, half, and *sphaira*, globe), and the part south of the equator the southern hemisphere.

While the orange (earth) is kept in the position shown in the picture, the lamp (sun) will always shine on one half of it, while the other half will be in the dark; and this will be the same if the orange be kept spinning round like a top, and be also moved round the lamp on the edge of the table. The side toward the lamp will always be light, and the side from it will always be dark; and if the orange be turned steadily all the time, the light side will be light just as long as the dark side is dark. Thus the lightness and the darkness will be divided evenly. So in the earth, if the axis were straight

up and down the sun's light would always shine evenly on one half at a time, and the days and nights would be of equal length.

Now, instead of setting the orange straight up, as in Fig. 1, set it so that the needle will slant, making

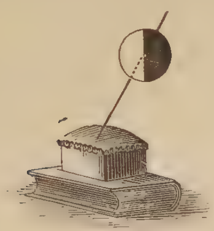


Fig. 2.—Real Slant of the Earth's Axis.

the upper end furthest from the lamp, as shown in the second picture, Fig. 2. If you now twist the knitting-needle so as to turn the orange round, you will see that the light never shines on the part near the north pole, and always shines on a part round the south pole while the parts round the equator become light and dark as the orange turns round.

Stick a pin in the orange about halfway between the equator and the north pole, and call it New York. You will see, as it moves round the orange, that it has a much longer journey on the dark side than it has on the light side. At New York, therefore, when the earth is in the same position to the sun as the orange is to the lamp, the night is much longer than the day. At the same time it is always dark at the north pole and always light at the south pole.

Move the pin-cushion and orange one fourth way round the table, keeping the knitting-needle always slanting in the same way. The two poles will then be equally distant from the sun, and if the orange be turned round it will be seen that the light strikes both poles at the same time, so that the journey of every part of the orange through light and darkness is equal. When the earth is in this position, therefore, the days and nights are of the same length all over the world.

Next move the pin-cushion and orange another fourth way round, still keeping the needle slanting in the same way; but, being on the other side of the lamp, its top, or north pole, will slant toward the lamp. You will now see that the light never shines on the part of the orange near the south pole, and always shines on the part near the north pole, while the parts around the equator become light and dark, as the orange moves round, as before. The pin which stands for New York has now a much longer journey round the light side of the orange than it has on the dark side. At New York, therefore, the day is longer than the night. At the same time it is always light at the north pole and always dark at the south pole.

Move the orange round another quarter, and the poles will again be equally distant from the sun, so that its light will strike on both poles at the same time, and day and night will be again equal.

Thus the difference in the lengths of the days and night is shown to be caused by the different ways in which the axis of the earth lies toward the sun. The axis always slants in the same way, but in moving round the sun it lies in different ways toward it. This will be seen in the picture (Fig. 3), where the earth is shown in the same four positions in which the orange has been put. In each of these positions the earth's axis is shown with the north pole marked N. The sun is in the middle, marked S. The axes all slant in the same way, but when the earth is at A or at C, the two poles are the same distance from the sun; when it is at B the north pole is tipped toward the sun, and when it is at D the north pole is tipped the other way, or from the sun.

It is now easy to understand what makes the changes in the seasons. When the days are long and the nights are short in either the northern or the southern hemisphere, the sun shines during so large a part of the twenty-four hours that the earth gets heated and gives off its heat to the air, and this makes summer. But when the nights are much longer than the day, the sun does not shine on the earth for so long a time, and so it does not get so much heat, and this makes winter. In the picture, A shows the earth in the spring (about March 21st) in the northern hemisphere, and in the autumn in the southern hemisphere. The light of the sun just falls on both poles, and in all other parts of the earth the days and nights are of the same length. As the earth moves from A toward B, the light shines more and more on the parts beyond the north pole, leaving the south pole little by little, until at B it lights up the parts all round the north pole, N, while the parts round the south pole are left in darkness. It is therefore the long day at the north pole, and the long night at the south pole, which last for half the year, from the time the earth is at A until it reaches C. When the earth is at B it is summer (about June 21st) in the northern hemisphere, and win-

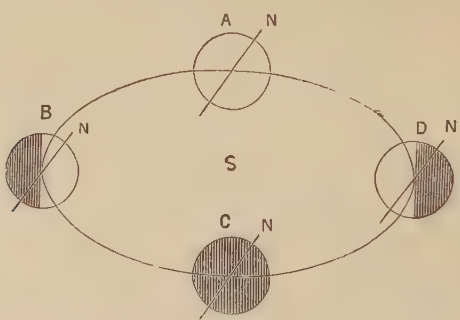


Fig. 3.—Positions of the Earth in moving round the Sun.

ter in the southern hemisphere. At the same time it is the middle of the long day at the north pole, and the middle of the long night at the south pole. As the earth travels from B to C the light leaves the north pole little by little, and begins to move toward the south pole, until, when the earth reaches C, the sun again shines equally on both poles, and in other places the days and nights are of the same length, just as when the earth is at A. When the earth is at C it is autumn (about September 23d) in the northern hemisphere, and spring in the southern hemisphere. As the earth moves from C toward D the light moves more and more beyond the south pole, leaving the north pole little by little, and the long day of the south pole and the long night of the north pole begin. These last until the earth gets round to A again, when the sun once more shines on both poles. When the earth is at D (about December 21st) it is winter in the northern hemisphere, and summer in the southern hemisphere. At the same time it is the middle of the long day at the south pole, and the middle of the long night at the north pole.

We thus see that the days and nights are caused by the spinning round of the earth on its axis once every twenty-four hours; and that the difference in the length of the days and nights is caused by the dif-

ferent ways in which the axis of the earth lies toward the sun, as the earth travels round the sun in its yearly course. We also see that the seasons are caused by the difference in the length of the days and nights in different parts of the earth. At the two poles there are but one day and one night in the whole year. At the north pole it is day for six months, from about March 21st to about September 23d, and night the other six months of the year. At the south pole it is night when it is day at the north pole, and day when it is night at the north pole. In all other parts of the earth the days and the nights are of different lengths, excepting about March 21st and September 23d, when they are of the same length everywhere. For several days before and after these times we cannot see any difference in the lengths of the days and nights, because it is only a few minutes.

The Atmosphere. The earth forms one of the planets which roll round the sun, and is therefore in the solar system, which is told about under UNIVERSE. It has only one satellite, or MOON, which rolls round it about once a month. It gets its HEAT and its light from the sun, the light which comes from the moon being only reflected LIGHT. It is surrounded by a great mass of AIR, called the atmosphere (air-sphere, from Greek *atmos*, air, and *sphaira*, a sphere), which covers it like an envelope, and which reaches as much as forty-five miles above its surface. The shining of the sun on the earth heats it, and this heats the air and causes the WINDS; it also causes vapor to rise into the air, and from it we have FOG, CLOUDS, DEW, RAIN, SNOW, and HAIL.

Attraction of Gravitation. The atmosphere around the earth, as well as everything upon the earth, is kept in its place by a force called the attraction of gravitation. If it were not for this force we should have no atmosphere, seas, lakes, or rivers; everything on the earth would fly off into space. When we drop a stone from our hand it falls to the earth, and we say it falls because it has weight; but what we commonly call weight is really a kind of attraction by which the earth is always drawing things to itself, just as a magnet draws iron filings. This is true, too, of everything on the earth —it attracts or draws toward itself every other thing; but the larger the thing the more it attracts, and as the earth itself is larger than anything on it, it draws toward itself everything on it with so great a force that little things cannot go toward each other. So, when we say that a thing is heavy, we mean that it has gravity and is drawn toward the earth by the force of gravitation.

If we tie a string to a stone and raise the stone up by it, the string is drawn into a straight line which points directly toward the centre of the earth. This would be the same, no matter on what part of the earth's surface we might stand, for there is no upper nor lower side, and those who stand on one side feel just the same as those on another side. From this we see that all things which fall anywhere on the earth always go toward the centre of the earth; also, that the atmosphere around the earth and all things on the earth are always attracted toward the same centre, and that this is what keeps them in their places. Knowing this, it is easy to understand why persons on the opposite side of the earth live there as easily as we do on our side, for *down* always means to them toward the centre of the earth, just as it does to us.

The attraction of gravitation was first found out by Sir Isaac Newton (C. P. P.), an English philosopher, who reasoned it out after seeing an apple drop from a tree, and thus became able to explain why all things are kept on the earth while it turns round on its axis.

Land and Water. The earth's surface is made up of land and water. There is a great deal more water than land; indeed, about three-fourths of the surface is covered by water. The water is all joined in one great body which we call the sea; but the land is much broken up by the way the sea runs into it, and some parts are cut off from the main body of land, so as to form islands. The masses of land, too, lie in such a way that the sea is cut up into parts. These great masses of land are called continents, and the parts of the sea lying between them are called oceans. If you look at a globe you will see that much more of the land lies north of the equator than south of it, and that more of the sea lies on the south side than on the north.

We can see that the surface of the land is uneven, broken up into mountains, hills, valleys, and plains, and we know in various ways that the bottom of the sea is very much like the land, but some of the valleys in the sea are much deeper than the height of the highest mountains on the land. The deepest parts of the sea are furthest from the land, and generally it grows shallow toward the land; but even in the middle of the sea mountains rise up from its bottom and form islands.

The water of the sea in the middle of the ocean is blue, because the color of pure water is blue, but nearer the land it is greenish, and this becomes tinged with brown or yellow along the coasts because the waves stir up the mud from the bottom or wear away earthy matter from the shores. In some places the sea has other colors from different causes: in the Gulf of Guinea it looks white; near Japan, yellow; in the Red Sea, in some parts of the Mediterranean, and near California, red; and round the Maldive Islands, black. The Black Sea is not named from its color, but on account of its many storms, and the White Sea gets its name from its snow and ice.

Sea water has a salt and somewhat bitter taste. It is made up like other water of OXYGEN and HYDROGEN, but it has besides many SALTS mixed in it, the principal of which are common salt (SODIUM chloride), MAGNESIUM, POTASSIUM, and CALCIUM. If all the salts in the sea were piled up on the continent of North America they would cover it all over, with a layer half a mile thick. All this great mass of mineral matter is washed out of the rocks and carried into the sea by streams and rivers. The water of all springs and rivers has some salt in it and therefore salt is all the time being carried in the sea. The water of the sea turns into vapor and rises into the air, from which a part of it goes back to the land again in the form of rain, snow, and hail, but the salts stay in the sea, and thus the water of the sea is always salt. It is also getting a little salter all the time, but so slowly that we do not notice it.

A good deal of the water which falls on the land goes back into the air as vapor, but much of it settles into the ground. Water sinks easily through sand and gravel. Some rocks, too, are so porous, or full of little holes, that water passes through them, and those which are close-grained have many cracks through which water runs freely. But wherever there is a bed of clay the flowing of the water is stopped. Therefore sandy soils are dry, but clay soils are wet, because they hold the water. All the water which goes down into the earth comes to the surface again, because after trickling down through the cracks in the earth, perhaps several thousand feet, it at last comes to some kind of rock through which it cannot pass. It then has to stop, but being all the time pressed upon by more water which follows it down from the surface, it has to try to escape in some other way; and so it is driven through other cracks up and down until it at last comes out

on the surface again at some place far distant from where it went in, and breaks out as a spring. In these long trips through the rocks which make up the earth's crust, water wears away the substance of the rocks little by little, and thus gets from them the salts useful to the life of plants and animals. The cracks and crevices in rocks are thus enlarged, and in this way great CAVES, sometimes many miles long, have been formed in different parts of the world.

The whole surface of the earth, too, is all the time being worn away by the action of water and frost, so that all the rocks, the hardest as well as the softest, are crumbling and washing away. The rains carry this powdered rock down from the hills and scatter it over the earth's surface. Part is collected in hollows and on sloping and level ground, and part is swept into brooks and rivers and carried into the sea, where it is made into new ROCKS. Thus the soil of the earth is made; sandy soil from sandstone, limey soil from limestone, and clayey soil from clay rocks; and thus it is made possible for PLANTS to grow and for ANIMALS to live upon the earth.

In the article ROCKS is told how the mountains have been formed on the earth, but these mountains do not look now as they did at first. Their tops and sides have been wasted away by frost and rains, which have carved them into cliffs and crags; and ravines and valleys have been cut out of their rocks by the endless flow of brooks and rivers. Thus great mountains have been carved into many ridges and valleys, and table-lands or highlands have been split up into smaller ridges and hills, and the soil is swept down on to the plains or into the sea.

The tops of the highest mountains on the earth are always covered with snow. This is because the higher parts of the AIR are very cold and when mountains are lofty enough to get into those parts which are below the freezing point, the vapor condensed from the air falls upon them as snow instead of as rain. During summer the heat melts the snow from the lower parts, but does not melt it on the upper parts where it is too cold, so that there is a line above which the snow does not melt. This line, which is called the snow line, differs in different parts of the world. In the warm countries near the equator it is nearly three miles (about 15,000 feet) above the sea, but at the two poles it is almost down to the level of the sea. As snow often falls on places above the snow line, it would soon become piled up very high if there were not some way of getting rid of it. When there is much snow the pressure of that which is above squeezes the lower layers into a solid mass, which becomes frozen, and in time this is crowded slowly down some valley until it reaches a point where it melts and flows away as a river. This, which is really a river of ICE, is called a glacier.

Glaciers are all the time grinding up rocks over which they pass, and pushing down large quantities of mud and stones, which find their way into the rivers, and thence on to the lowlands and into the sea; but they are also carrying down great masses of rock, earth, and stones which have tumbled down on them from cliffs as they flowed along. Sometimes masses of rock as large as a house are thus carried down and left in the valleys wherever the ice happened to melt, and sometimes large valleys have been entirely ruined by having thousands of tons of stones and mud left in them.

History of the Earth. The science which tells about the way the earth was formed is called geology (Greek *ge*, the earth, and *logos*, a discourse or talk), and he who teaches that science, a geologist. Almost all geologists now think that the earth was in the beginning a mass of incan-

descent (glowing, from Latin *in*, and *candere*, to be white hot) fluid matter, much like what the sun now is. As it cooled little by little a crust was formed on the outside, at first in patches, then in larger masses which finally covered the whole surface. Then the vapors which had formed an atmosphere around it condensed and poured torrents of rain over its surface and made seas. As the crust grew in thickness it cooled, and this contracted the mass and caused it to yield and break in places, thus forming mountains. The rocks composing this crust, thus formed by the action of fire are sometimes called igneous (Latin *ignis*, fire) rocks, and sometimes Plutonic rocks, after Pluto, the heathen god of the fiery regions; and as they were the first to appear, they are also called primary (Latin *primus*, first) rocks, and the age in which they appeared the primary age. Among the primary rocks are granite, porphyry, basalt, serpentine, and gneiss, and to this same age belong the metals and the precious stones, both of which owe their origin to fire.

Upon these primary rocks, thus laid like an arch over the central fires of the earth, have been built up, in the course of ages, other kinds of rocks, formed mostly by the action of water. While the earth's crust was thin, only small elevations were produced by its crackings, but when it grew thick and firm it was broken only by very violent movements, by which the Himalayas, the Andes, and other grand mountain chains were thrown up. These upheavals made changes also in the level of the sea and caused deluges which buried under water many parts of the earth's surface, depositing upon the primary rocks matter that also became solidified into rocks which in time were thrown up by some other great upheavals. These rocks, among which are coal, chalk, limestone, and sandstone, differ from the primary rocks, which are all melted in a mass together, in being formed in strata or layers, just as they had settled, one layer above another, at the bottom of the sea. They are called, for this reason, aqueous (Latin *aqua*, water) rocks, and sometimes Neptunian rocks, the latter after Neptune, the heathen god of the sea.

The aqueous rocks, thus formed over the igneous rocks by the action of water, are divided by geologists into four groups: the transition rocks, secondary rocks, tertiary rocks, and quaternary rocks, and the times in which they were forming the transition, secondary, tertiary, and quaternary periods. In each of these periods the rocks bear certain marks by which they can be distinguished from each other, so that the skilled geologist can tell by examining them to what age of the world's history they belong and what other things are likely to be found with them.

The **Transition Period** was a time of change, when life began. Of course, there could have been no animal life on the earth while it was in a burning state; but as soon as the crust had become somewhat cooled, living creatures and plants began to appear. These were very different from any of the animals and plants of to-day. The heat was at first the same all over the globe from the equator to the poles; there were neither seasons nor climates, and the same kinds of animals and plants were found in all parts. The animals were the lowest kind of living things, such as CRUSTACEANS, MOLLUSKS, and a few fish in the seas, the waters of which were warm and still covered most of the surface. Among the most numerous of these first inhabitants of the earth were small crustaceans, called trilobites (Greek *treis*, three, *lobos*, lobe) named from the three lobes or divisions of which their bodies were made up. No trilobites now exist, but their fossil (Latin *fossilis*, dug up) remains are often found

so well preserved that their eyes can be seen, and the geologist knows that the rocks in which they are belong to the transition period, the earliest age of life on the earth. No air-breathing animals lived then, for the atmosphere contained much more CARBONIC ACID than now, but plants, whose food is carbonic acid, thrived, and the earth soon became covered from pole to pole with immense forests of palms, bamboos, gigantic ferns, and cone-bearing trees, which in the lapse of ages settled down under the sea and became COAL. The transition period was chiefly marked then by the growth of vegetation.

The **Secondary Period** of the earth's history may properly be called the reptilian age, because reptiles were so numerous and of such gigantic size and singular forms. They are known to us only through their bones found in rocks, but so accurately has their history been preserved that the geologist can draw us their portraits and tell us how they lived and even the nature of their food. Among these reptiles was the ichthyosaurus (Greek *ichthus*, fish, and *sauros*, lizard), or great fish-lizard, twenty to thirty feet long, its jaws armed with teeth like a crocodile's and its eyes, as large as a man's head, protected by bony plates; the plesiosaurus (Greek *plesios*, near, and *sauros*, lizard), twenty feet long, with a body like a turtle's and a long snake-like neck with a lizard's head; the labyrinthodon (Greek *laburynthos*, labyrinth, and *odous*, tooth), so called because its teeth were like a labyrinth, a kind of monster toad, as large as an ox; and the pterodactyl (Greek *pteron*, wing, *daktulos*, finger), a lizard with huge wings on its paws like a bat and long jaws armed with sharp teeth. The sea too was filled with many kinds of mollusks, most of which are now known only through their shells preserved in rocks. At the close of this period appeared the first bird, the archæopterix (Greek, *archaios*, ancient, and *pterux*, birb), more like a lizard than a bird; and the first MAMMAL, a pouched animal, somewhat like an opossum. The trees, too, began to change their kinds, and to become more like those now living.

In the **Tertiary Period** the crust of the earth had become thick enough to cut off the heat from its centre, so that it gradually grew cooler. Most of the great reptiles had disappeared, the earth became covered with many kinds of mammals, and cetaceans, or animals of the whale kind, first appeared in the seas. Among these mammals were the palæotherium (Greek *palaios*, ancient, and *therion*, animal), a thick-skinned animal with a trunk like a tapir's; the dinotherium (Greek, *deinos*, terrible, and *therion*, animal), like the elephant, but larger; the mastodon (Greek *mastos*, a teat, and *odous*, a tooth), so called from its teat-like teeth, another great elephantine animal, with long straight tusks, which once roamed over the North American continent; the glyptodon (Greek *gluptos*, carved, and *odous*, tooth), so called from its fluted teeth, a huge armadillo more than twice as large as those now living; the megatherium (Greek *megas*, great, and *therion*, animal), a sloth as large as an elephant, and the sivatherium (from Siva, East Indian goddess, and Greek *therion*, animal), a stag as large as an elephant, with four horns, which lived in India. In the beginning these mammals spread from pole to pole, as is proved by their fossil remains. Many birds and insects too appeared; trees and other vegetation began to look still more like that of to-day, and the surface of the earth was covered with flowers. Though its crust had cooled greatly, its surface still had a tropic heat; but in time it began to grow cooler at the poles, which were furthest from the sun's heat, and climates began to be formed. At the end of this period the continents and the

seas were nearly as we now see them, the air had become purified, and the earth was ready for man.

The **Quaternary** (Latin *quatuor*, four) **Period**, or the period of the earth's history in which man has lived, was marked in the beginning by floods which buried the polar regions and the parts which are now temperate under layers of clay, sand, gravel, and sea-shells; by the upheaval of mountain ranges, and by the invasion of the land by great masses of ice. It is not known exactly what brought about this wonderful change, which swept off the tropical forests and buried in snow and ice most of the singular animals that had lived in them. The waves of this immense sea of ice, rolling down the mountains, tore off parts of them and bore them onward until they finally melted and dropped them hundreds of miles away. In this way the great bowlders found in middle Europe and in the western parts of the United States were carried far from the mountains where they were formed. At this time, sometimes called the glacial (Latin *glacies*), ice period, animals were very plentiful. Great hairy elephants, called mammoths, larger than any now living, wandered in droves over the northern countries. In Siberia and in the islands off its coast their remains are so plentiful that their tusks furnish immense quantities of ivory. In the Museum of St. Petersburg is the skeleton of a mammoth whose body had been preserved in the ice in Siberia. When first found the flesh was still so sound that the dogs and wild beasts ate it. This shows that the ice flood overwhelmed the northern regions so suddenly that these animals were caught and frozen up as soon as they were killed; but it is impossible to tell exactly what caused it nor how long it lasted. Together with the mammoth lived the woolly rhinoceros, the cave bear, the cave tiger, the cave hyæna, gigantic stags, and many large birds, whose bones have been found in CAVES. We know also from sure signs that MAN lived at the same time with these animals, but, unlike most of them, he survived the age of ice and his descendants are now able to read the history of the earth in the rocks that hold their bones.

The word earth is from the Anglo-Saxon *eorthe*, earth.

EBONY, the wood of several trees which grow mostly in the East Indies. Black ebony is brought chiefly from Ceylon. It is much used in ornamental furniture, mostly as a VENEER, or thin layer to be glued on to some other wood. It is very hard and heavy and takes a fine polish. There are other colors of ebony, such as red, yellow, green, and a striped kind—black and white—but the black kind is most used. The ebony is only the core or heart of the tree, the outer wood being light-colored and soft; it is therefore scarce and very costly. The persimmon tree of the southern United States is of the same family of trees as those from which we get ebony. Most of the furniture called ebony is made of cherry wood dyed black.

The word ebony comes from the Latin *ebenus*, Greek *ebenos*, which is from the Hebrew *eben*, stone; and the wood is so called on account of its hardness.

EEL, a fish with a long snake-like body and a soft slimy skin, covered with scales so small that they can scarcely be seen. Eels live both in salt and fresh water, usually on muddy bottoms. In the winter they make beds about a foot deep in the mud, where they lie torpid or numb without food until spring. There are about fifty kinds of eels in different parts of the world, but none are found in very cold climates, like the Arctic regions. The common eel of the Northern United States is from six inches to two and a half feet long, but what is called the conger eel is three to five feet long. The European conger, which is caught

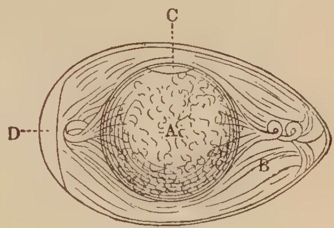
on the coasts of France and of England, is often ten feet long, and some have been caught which weighed more than a hundred pounds.

The **Sand Eel** is found in both Europe and America, but only in salt water. It is so called because it lives in the sand, into which it can dart head foremost and bury itself very quickly. In Long Island Sound and along the coast north of New York these eels make the principal food of the blue fish and bass, and other eels and porpoises also prey upon them. Many are caught for food, and on the fishing grounds of Newfoundland they are used as bait for cod.

The **Electrical Eel,** found in the rivers and ponds of the north parts of South America, has the power of giving an electrical (see ELECTRICITY) shock strong enough to knock down a man. The fish uses this to defend itself against its enemies and to destroy the life of its prey. When the Indians, who eat them, wish to capture some, they drive wild horses into the pool where they are, and after the eels have used up their electricity on the horses, they take them without fear. It is said that some of the horses are usually killed by the shocks.

The word eel comes from the Anglo-Saxon *æl*.

EGG. Eggs are laid by BIRDS, REPTILES, AMPHIBIANS, FISHES, CRUSTACEANS, and INSECTS. Birds' eggs are oval (from Latin *ovum*, an egg), and are covered with a thin shell, white or colored, formed mostly of carbonate of lime (CALCIUM carbonate). The shell is lined with a tough skin, and inside of this is a mass of ALBUMEN, *B*, called the white, which encloses the yellow or yolk, *A*. The yolk, *A*, which has a thin skin around it, has in it a little jelly-like speck or germ, *C*, from which the young bird is hatched. The yolk is so made that the germ is always uppermost, no matter how the egg lies, so that when the hen is sitting the germ is always nearest to the warmth. The yolk and the albumen furnish food to the bird while it is in the shell. At the larger end of the egg, *D*, between the skin and the shell, is a space filled with air for the bird to breathe. There is more OXYGEN in this air than in the outside air. In most



Egg.

animals other than birds the outer shell and the white are wanting, but the yolk and the germ are found in the eggs of all animals. Birds usually lay their eggs in nests (see BIRDS' NESTS).

The eggs of almost all the common birds are told about in the articles on those birds. In some countries the common people almost live on the eggs of the wild water birds which are found on their shores. The collecting of these egg is a very dangerous business, as the nests are usually built high up in the cracks and on the ledges of rocks overhanging the sea. The eggers, or men who gather the eggs, have to climb up these rocks and walk along narrow ledges, where a single misstep would be sure death. In the Faroe Islands, where the bird rocks are very high and steep, men are let down from the tops of the cliffs by strong ropes, as shown in the picture.

The rope, on the end of which is a small seat for the egger to sit on, is about two inches thick. A beam is laid on the edge of the cliff to keep the rope from being cut by the rough rock. The egger, who is let down by four or five other men, has tied round

his waist a cord, by pulling which in certain ways he can make signs to the men above. The eggers capture young birds as well as eggs, either by seizing them with their hands or by throwing a net over them. The man on the left side of the picture is catching a bird with one of these nets.

The skill of the eggers is very great. They will put their feet against the side of the rock and push

Bird and Egg Hunting in the Faroe Islands.

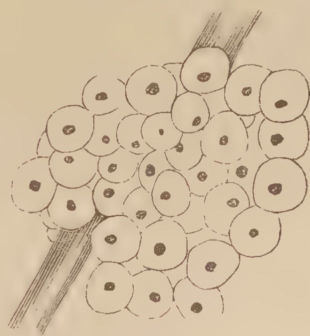
so as to swing themselves out many feet, so that they can see the places where most of the nests are. In some places there are deep holes like caves in the rock, in which great numbers of birds live. A story is told of one of these men who had swung himself into one of these caves, and finding the floor strewn all over with eggs became so excited that he lost his rope, which swung out beyond his reach. Now and

then the wind swung it in toward the rock, but never near enough for him to catch it. He was greatly frightened, for he was under the rock so that he could not see his friends above, and the sea roared so loud that they could not hear his cries. He knew that if they pulled up the rope and did not find him on it they would think that he had lost his hold and fallen into the sea, and he would then be left to starve in the cave, At last, almost wild with despair, he made up his mind to spring and try to catch it as it swung in the air. It was a dreadful thing to do, for if he failed he would fall into the sea or on to the rocks, hundreds of feet below. He watched until the wind swung the rope toward him, and, springing, fortunately caught it with his hands, and was drawn up safely to the top of the rock.

Great numbers of eggs and birds are collected every year in the Hebrides, and in the Orkney and the Shetland Islands. Near the coast of one of the Shetland Islands is a very high rock called the Pillar of Noss. The sea birds used to build their nests and hatch their young there year after year, for its sides were so steep and slippery that no man had ever been able to climb it; but at last a man went to its foot in a boat and crawled up its sides, carrying with him a strong rope, one end of which had been fastened on the highest part of an island near by. He reached the top after much toil and danger, fastened the rope there, and hung under the rope a stout basket, so made that it would slide along on it. By this means he was able to get a great many eggs and birds from the rock, and carry them across high up in the air above the foaming water to the island. This rope, which is still used to get eggs from the rock, is called by the people the Cradle of Noss.

The **Eggs of Reptiles** are usually pretty large, and have a large yolk for the young animal to feed on. They are covered with a thick tough skin like parchment, not hard like the shell of birds' eggs. They are laid in warm sandy places, in dunghills, or on heaps of vegetable matter. where they are left to be hatched by the heat of the sun or the warmth from decay. Crocodiles and alligators lay twenty to sixty eggs, tortoises and turtles twenty to twenty-five, serpents ten to fifty, and lizards eight to twelve.

The **Eggs of Amphibians**, such as frogs and toads, look like little lumps of jelly, much like the white of a hen's egg, with a black speck in each. They are usually found in bunches fastened to grass or sticks in the water near shore, like the one

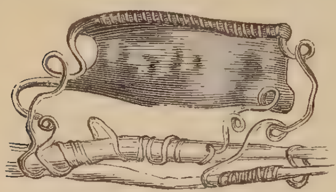


Eggs of the Frog.

in the picture. The black specks are the real eggs, and the jelly keeps them together and gives food to the young when born. The eggs of tree frogs and of toads look much the same, only the first are laid separately instead of in bunches, and the second are fastened together in strings something like a string of beads. The tree frog goes into the water only in the spring to lay its eggs, and when the young are large enough they leave the water and live in trees.

The **Eggs of Fishes** are in little sacs called the roe or spawn, which sometimes contains thousands and even millions. The roe of a single

codfish has been known to hold 9,000,000 eggs. The spawn is laid in different places, according to the kind of fish; some on beds of sand or gravel along the seashore, some on the leaves of water plants and on seaweed, and some in shallow waters at the head of rivers, whither many



Egg-case of the Shark.

sea fish go every year to lay, or spawn, as it is called. Some fish, however, such as the shark and the ray, lay but few eggs, and take more care of them than do fishes that lay a great many. Each egg is enclosed in an oblong horny case, which is attached by long tendrils to seaweeds. The shell is thin at one end, and the young fish, when grown large enough, breaks its way out. The empty shells are sometimes found along the seashore, and are called "mermaids' purses," or "sea-purses."

The **Eggs of Crustaceans** are usually carried about by the female, fastened under the body, until they are hatched. More than 12,000 eggs have been found under a lobster, and it is said that the crawfish will lay more than 100,000. They are laid in bunches glued together with a sticky fluid. These eggs are very small at first, but when ready to be hatched they are about the size of small shot. It usually takes six months to hatch young lobsters. When the time comes the mother shakes the eggs up by a movement of her tail, and this breaks the shells and lets the little ones out; and in a day or two she gets rid of all her burden. The little red things called the coral in boiled lobster are eggs.

The **Eggs of Insects** are of different shapes and colors, but generally

Eggs of Butterflies and Moths.—Magnified.

white, yellow, or green. Those of bees, flies, and beetles are usually barrel-shaped, and those of butterflies and moths are mostly round. In the picture the eggs are much enlarged; their real size is shown on the leaf. They are almost always laid near or on the objects on which the young will feed when hatched; thus the flesh-fly lays its eggs in meat, the cheese-fly in cheese, the tumble-bug in a ball of dung which it rolls away into a safe place; the vegetable-eating insect on the leaves of the plants on which it lives, and the mosquito on the surface of quiet pools in a boat-shaped mass which floats on the water. The flea is said to lay only about 12 eggs; and flies and beetles about 50; but the silk-

worm produces from 500 to 2000, the queen bee as many as 50,000, and the white ant many millions.

The **Eggs of Mollusks** differ much in size and shape. Those of the oyster are very small, and are stuck together with a gluey fluid. They are carried between the folds of the

Eggs of the Mosquito.—Magnified.

outer skin called the mantle until they are hatched. Some say an oyster can carry 100,000 eggs, and others say even 2,000,000. Most other kinds of shell-fish do not carry their eggs around with them, but leave them to take care of themselves. The cephalopod mollusks, such as the cuttle-fish, lay their eggs in bunches and fasten them to sea-weed. Fishermen call them sea-grapes, because they look much like a bunch of grapes.

The word egg comes from the Anglo-Saxon *æg*.

EIDER DUCK. This bird, from which eider DOWN is got, is nearly twice as large as a common duck, and has a short neck and rather long legs. The plumage of the male is very handsome; the upper part of the head is bluish black and white, the neck pale green and white, the breast buff, the back white, and the lower parts black. The females are smaller than the males, and their plumage is generally brown barred with black.

Eider ducks live chiefly in cold countries, especially in the most northern parts of America, and in Norway and Iceland. In Iceland and Norway the places where they build their nests are valuable property and are watched with as much care as farms are in other countries. In Iceland it is against the law to kill a duck in the breeding season. The birds seem to know that they are safe, and will not stir when people go close to them. They build their nests wherever they find a good place, on the ground, on tops of walls, on the roofs of houses, and sometimes even in the houses. A traveller in Iceland once saw some ducks sitting on their eggs in a church. The nests, which are round and deep, are built of small twigs, laced together with moss and sea-weeds. Each bird lays usually five or six olive-gray eggs, somewhat larger than common duck eggs. Every nest is lined with down, which the bird tears from its own breast, and in which it buries its eggs. This keeps them warm when the mother leaves the nest for food. The owners of the ground take the down out of the nests, getting about a hatful from each. As soon as the mother finds that her nest has been robbed she again strips the beautiful brown down from her breast and covers her eggs up, to keep them at the right warmth. But the down is robbed a second time, and as the mother has no more the male bird strips the snow-white down from his own breast. This, too, is sometimes taken, but not often, and the poor bird is generally left to hatch her young in peace.

The eider duck belongs to the order *natatores*, or swimming BIRDS.

The word eider is from the Danish *edder* or *eder*, Swedish *ejder*.

ELDER, a common shrub, bearing clusters of white flowers followed by small black berries, and which is often found growing on the borders of fields. The young stems of the elder are hollow and filled with a soft pith which is easily pushed out with a stick or stout wire. As they are quite straight they make fine pop-guns. The pith or inside makes the best of pith-balls for electrical experiments. The juice of the berries, which is a bright crimson, is often made into elder-berry wine. A kind of perfumed water, called elder-flower water, is

made from the flowers; it is used in perfumery and confectionery.

The word elder is probably from the German *holder*, elder, which is from *hohl*, hollow, and *der*, tree.

ELECTRICITY. It is believed that electricity and light are the same thing, or rather that light is made up of electrical waves. Heinrich Hertz, a German scholar, has shown it to be probable that all the energy that comes from the sun is electrical, and is changed when it reaches the earth into all the known forms of power and motion. The life in growing plants, the strength of animals got from vegetable food, the heat and light stored up in coal, the power of the steam engine—in short, all kinds of power on earth come to us in the form of waves of electricity in beams of light from the sun. Faraday, an English philosopher, had suspected this, and Maxwell, another Englishman, had found out that the waves of electricity and light travelled at about the same rate, but Hertz showed that they were the same thing. It was found out more than two thousand years ago that when a piece of amber is rubbed with silk it will attract or draw toward itself light bodies such as bits of dry paper, straw, or leaves, but it was not known why it does so. About three hundred years ago, Dr. Gilbert, an Englishman, found out that many other things, such as sealing-wax, glass, and sulphur will do this like amber; and he was the first one to use the word electricity, which he made from *elektron*, the Greek word for amber, as a name for that which makes the amber, glass, etc., act in this way. But although he gave a name to it, he did not know exactly what it was, and it was not until a little more than a hundred years ago that Dr. Franklin found out, by flying a KITE, that electricity and lightning are the same thing. Since that time a great many people have carefully studied it, and our knowledge of it has grown so wonderfully of late years that we have learned how to make it very useful. It is by means of electricity that we are enabled to send messages to distant places by TELEGRAPH and to talk with persons hundreds of miles away with the TELEPHONE.

Although we know that electricity is the same as lightning, we still call it by the name which Dr. Gilbert gave it; and give the name LIGHTNING to the flashes of electricity which we often see in the air during thunder storms. There is electricity in everything. If you stroke a cat's back in cold weather, you will hear a snapping sound and will feel a tingle in your fingers; and if it be done in the dark you will see sparks. This is because the rubbing wakes up the electricity in the cat's fur and in your hand; and it shows that there is electricity in you as well as in the fur of the cat. Some people have much more electricity in them than others; so much, indeed, that they can light the gas by touching it with the finger after waking up the electricity in themselves by rubbing their feet on the carpet. A spark will leap from their finger to the metal burner, and set the gas on fire. Some animals, too, like the electrical EEL, have the power of waking up electricity in themselves, and of shocking others.

Conductors and Non-Conductors. Electricity moves over some things very freely, and over other things with great difficulty, or scarcely at all. Thus, if the electricity in a glass tube be excited by rubbing it with silk, the glass will have the power of attracting bits of paper and other light things only where it has been rubbed; but if a metal rod be held by a glass handle and the electricity in it be excited in any way, all parts of it will attract light bodies. It is thus shown that electricity can spread itself all over a surface of metal, but that it cannot do so over one of glass. Glass is therefore said to be a non-

conductor of electricity, and metal a conductor. There are some other things, such as charcoal, water, wet snow, and the bodies of animals, which are good conductors, but not quite so good as metal; while, on the other hand, there are other non-conductors, of which gum-lac, gutta-percha, amber, resins, sulphur, and wax are better than glass, and silk, wool, hair, feathers, cotton, paper, and dry air are not quite so good non-conductors as glass.

Positive and Negative Electricity. But these things do not all give out the same kind of electricity, for there are two kinds of it. This can be shown by means of an electrometer, an instrument made up of a little pith ball, A, hung up by a silk thread, B, on a convenient stand, C, as shown in the picture, Fig. 1. If a glass rod be rubbed with silk and then brought near the pith ball, the ball will first be attracted, or drawn toward it, and then repelled, or driven away from it. If a piece of sealing-wax be then rubbed with a dry flannel and brought near the pith ball, it will be found that the ball, which was driven away by the glass, will be attracted by the sealing-wax. Thus we see that there are two kinds of electricity, one which is got from excited glass and one from excited sealing-wax. When the excited glass was touched to the pith ball, the ball took from it a part of its electricity. This electricity stayed in the pith ball, because it could not pass off by the silk thread, which is a non-conductor. Now, as the ball, as soon as it was filled with electricity, was repelled by the glass, we see that bodies filled with the same kind of electricity repel each other. On the other hand, the ball, when filled with the kind of electricity that is in the glass, was attracted by excited sealing-wax; and so we see that bodies filled with different kinds of electricity attract each other. If the pith ball had been filled with electricity from excited sealing-wax, it would have been repelled by the sealing-wax and attracted by the glass.

Fig. 1.—Electrometer.

In bodies which have not been excited by rubbing, or electrified, as it is called, the two kinds of electricity are mixed together in equal quantities; and when we rub them we do not make electricity but merely separate the two kinds from each other. Thus, when we rub glass with silk, one kind of electricity stays with the glass and the other kind goes to the silk. This always happens when electricity is excited by rubbing—one kind is made in the rubber and the other kind in the body rubbed; and one kind cannot be made without making the other kind. To mark these two kinds of electricity the one which is in the stick of glass when rubbed with silk is called *positive* electricity, and the one in the stick of sealing-wax when rubbed with flannel is called *negative* electricity. In the same way, that in the silk with which the glass is rubbed is negative electricity, and that in the flannel with which the sealing-wax is rubbed is positive electricity. But the kind of electricity which a body gets when rubbed depends on the body against which it is rubbed. Thus, if amber be rubbed with sulphur it will get positive electricity; but if it be rubbed with glass, it will get negative electricity.

Insulators. In making experiments with electricity, we have to find some way to keep it when it is made. This can only be done by surrounding it with things which are non-conductors. Dry air is a non-conductor, and experiments can therefore be made better in cold weather, because the air is then dryer than in warm weather, when it is apt to be filled with dampness, and as water

is a conductor of electricity, the more dampness there is in the air, the harder it is to make and to keep electricity. When a body which has been electrified is so surrounded by non-conductors that it is cut off from all other things, it is said to be insulated (Latin *insula*, an island), and the non-conductors by which it is insulated are called insulators.

Electrical Machines. We usually get electricity by rubbing glass, and there is a machine, called an electrical machine, made especially for this purpose. This machine is made up of three principal parts; the body which is rubbed, and which is usually either a round glass cylinder or barrel or a round plate; the rubber, which is generally a leather cushion

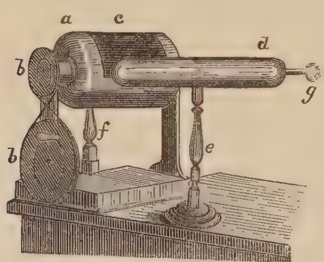


Fig. 2.—Cylinder Electrical Machine.

stuffed with hair; and the prime conductor, on which the electricity is collected and kept. In the picture, Fig. 2, is shown a cylinder electrical machine; *a* is the glass cylinder or barrel, and *b b* are the two wheels by which it is made to turn round. There is a handle on the lower wheel to turn it by, and a cord which goes round both wheels so that when the lower one is turned the upper one is turned also. On the other side of the barrel is a rubber, held up by the glass column, *f*, which presses tightly against the barrel. The rubber is smeared over with an AMALGAM, made of tin, zinc, and mercury melted together, then ground to powder and mixed with lard. A piece of oiled silk, shown at *c*, is fastened to the rubber and lies on the face of the barrel. This saves the electricity of the glass from being carried away by the air, and keeps the dust off the cylinder. At *d* is the prime conductor, which is made of hollow brass, and which is held up by the glass column, *e*, so that it is insulated and can keep what electricity it gets. When the barrel is turned round it is rubbed hard by the rubber, and electricity is got from it.

Now, you will remember that there are two kinds of electricity in everything, and that when we rub two things together we do not make electricity but only separate the two kinds from each other, one kind keeping on the thing rubbed and the other kind on the rubber. So when the glass barrel is turned round, positive electricity is waked up on the glass, and negative electricity on the rubber. To get rid of the negative electricity a little metal chain is usually fastened to the rubber by one end, and the other end is let lie on the floor or ground; and as fast as the negative electricity is excited on the rubber it passes down this chain to the earth and is scattered and lost. The positive electricity which is on the glass barrel does not follow the negative electricity, but passes to the conductor. On the end of the conductor next to the cylinder are some small metal points. These draw the electricity from the glass barrel to the conductor, which is able to keep all it gets because it stands on a glass column, which is a non-conductor. By turning the barrel long enough we can thus get a great deal of positive electricity in the conductor. The plate electrical machine, the form of which can be seen Fig. 3, works in the same way as the barrel machine.

The electricity is thus imprisoned in the conductor, but it will go away quickly enough if it gets a chance. If you put your finger near the knob *g* at the end of the conductor, you will hear a snapping sound, a spark will leap from the knob and you

will feel a tingling in your finger. This is the electricity, which leaps from the receiver to your finger and passes thence through your body to the earth. The reason is this: You

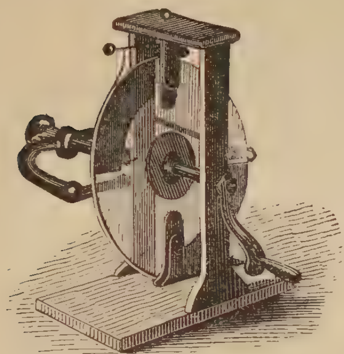


Fig. 3.—Plate Electrical Machine.

have both positive and negative electricity in your finger, while there is only positive electricity in the conductor; the two kinds in your finger are separated by the positive electricity of the conductor, which takes the negative kind to itself and drives away the positive, which is of the same kind as itself, to the earth through your body. The two different kinds of electricity have such a liking for each other that they rush together quickly, and in doing so form a spark. Sparks will continue to leap from the round knob of the conductor to your finger as long as the conductor is kept filled with electricity; but if you hold a sharp point, like that of a fine needle, near to the knob, there will be no spark, but the electricity will be carried off in a stream just as fast as it is made. This is because the point draws it away so fast that it does not get time to gather enough to form a spark; and this shows the use of lightning-rods on houses. These, which are always pointed, and which run into the ground, quietly draw off the electricity from thunder clouds that come near, just as the needle in your hand does, and carry it down into the earth. In like manner, if the knob on the conductor were sharp pointed instead of round, the electricity would escape into the air as fast as it is made.

The electricity passes through you into the earth because your body is a good conductor; but if your body be insulated or cut off from the earth by some non-conductor, the electricity will not pass through you, but will collect in you just as it does in the conductor of the electrical machine. You can insulate your body by standing on an insulating stool, which is a common wooden stool with glass legs. If, while standing on this stool, you hold in your hand a chain fastened to the knob *g* of the conductor (Fig. 2), most of the electricity will pass from the conductor into your body, and will stay there, because the glass legs keep it from passing off to the floor and thence into the earth. When thus filled with electricity your hair will stand up straight. A small figure, like a human head covered

Fig. 4.—Electrified Head.

with long hair, makes a very amusing toy, for its hair will rise on end when it is put on the conductor and electrified. If another person puts his finger to your nose, chin, or any other part, when you are thus electrified, the electricity will pass to him with a spark, and he will feel a tingling in his finger, just as you did

in drawing the electricity from the conductor.

Leyden Jar. The electricity which collects in the conductor can easily be drawn off and bottled up in what is called a Leyden jar, because the first one was made in Leyden, Holland. This is a glass jar, like the one shown in the picture (Fig. 5), coated inside and outside with tin foil, excepting a small part at the top. A brass rod with a knob at the end goes through the cork and down into the jar until it touches the inside coating of tin foil. If the knob of this jar be held about half an inch from the conductor, sparks will pass for some time from the conductor to the knob of the jar, and will then cease. The jar is then said to be charged, that is, the coating on its inside is as full of electricity as it will hold. The jar can be charged only when the outside is connected with the earth; if the outside be insulated, no electricity can be collected in it. It is enough to hold the outside of the jar in the hand, for then it is connected with the earth through the body. The positive electricity from the conductor then passes into the inside coating of the jar. It separates the two kinds in the outside coating, driving off the positive electricity into the earth and drawing the negative toward itself; but it cannot get the negative electricity because the glass between the outside and inside coatings of the tin foil keeps them from coming together.

Fig. 5.—Leyden Jar.

Thus we have two kinds of electricity, one on the outside and one on the inside of the jar, both anxious to mix together, but kept from doing so by the glass between them, through which they cannot pass. They will leap together at the first chance they get, as you will see if you put one hand on the outside coating and bring the other near the brass knob on the top of the jar. The charge will then pass through your body, and you will feel a painful shock, chiefly at the wrists, elbows, and across the chest. This, which is called an electric shock, is really the same as a slight stroke of lightning.

Many persons can take a shock at the same time by taking hold of one another's hands. If one person at one end of the line puts one of his hands on the outside of the jar, and another person at the other end then touches the knob on top of the jar, the shock will pass through the bodies of all at the same time.

It is usual to discharge a jar with a discharging rod, as shown in the picture (Fig. 6). This is made of a bent wire with a brass ball on each end, and with a glass handle. When one of the balls is touched to the outside coating of the jar and the other to the knob of the jar, the two kinds of electricity will rush together with a bright spark and a loud snap, and the jar will be discharged. By putting together a large number of Leyden jars and joining their knobs with wires so that they can all be discharged at once, we can get together an enormous quantity of electricity. When jars are thus put together, it is called an electrical battery. Such a battery must be very carefully used, as there is electricity enough in one to kill a man as quickly, and in the same way, as if he were struck by lighting.

Fig. 6.—Discharging Rod.

Voltaic Batteries. It has been shown how electricity is drawn off in a stream from the conductor of the electrical machine when a sharp point is held to it. This stream,

which flows quietly and unseen, is called an electric current. Electric currents will flow over thousands of miles of wire as quickly as a flash of lightning, and it is by using them that we are able to telegraph to the most distant parts of the earth.

But the currents used in telegraphing are not those got from an electrical machine, but from a kind of battery first made by an Italian named Volta, and therefore called the Voltaic battery. Such a battery is made up of several glass cups, as shown in the picture, each of which

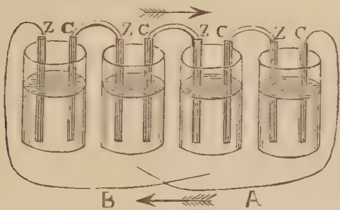


Fig. 7.—Voltaic Battery.

is partly filled with a mixture of sulphuric acid and water ; in each cup are placed also a plate of zinc, marked Z, and a plate of copper, marked C, in such a way that the copper plate of the first cup is connected with the zinc plate of the second cup by a wire or strip of metal soldered to the plates ; the copper plate of the second cup to the zinc plate of the third cup by a like wire or strip, and so on in the same order through all the cups. If now a wire be fastened to the zinc plate in the first cup and another wire to the copper plate in the last cup, and the ends of the two wires be brought together, as in the picture, a current of positive electricity will flow round and round in the way the arrows point. Such a current is called an electric circuit. The two wires are called the poles of the battery, the one marked A being called the positive pole, and the one marked B the negative pole.

Electricity thus produced is called Voltaic electricity. It is sometimes called also galvanism, or galvanic electricity, because Galvani, another Italian, found it out about 1790, but Volta made the first battery in 1801. Since then it has been much improved and there are now several hundred different kinds of batteries, generally named after the inventors, such as the Wollaston, the Smee, the Daniell, the Grove, the Bunsen, and the Leclanché battery. Though these work in the same way as the Voltaic battery, some of them differ from it in the form of the cups or cells and in the substances used to excite the electricity. Of these the Daniell battery, or some form of it like the Grove battery, is much used for telegraphing, and the Leclanché battery, which gives a weaker current, for telephoning. Batteries are often made of fifty or a hundred cells, and some have been built of even many thousand cells. Electric currents from such batteries have many important uses : they furnish the power not only of the TELEGRAPH and the TELEPHONE, but also of the electric bell, the electric clock, the burglar alarm, and many small machines. By means of such a current, too, water can be divided into its ELEMENTS, HYDROGEN and OXYGEN ; and iron and steel can be made into MAGNETS. Still another important use of it is told about in the article METAL WORK, under ELECTRO-PLATE. Where a very strong current is needed, as in electric lighting and the driving of large machines, the voltaic battery has now given place to the dynamo-electric machine, or the dynamo as it is commonly called.

Dynamo. This is a machine in which coils of wire surrounded by electro-magnets are turned swiftly by means of a steam engine. A very powerful current of electricity is thus obtained, very much stronger than that from a battery or even from an electrical machine. There are more than fifty kinds of dynamos, some of which are made up of numerous parts, and are hard to understand,

Among the principal ones are the Siemens, a German, and the Edison, an American machine. In all of them it is now necessary to have a steam engine, a water wheel, or some other power to make or collect the electricity, but it is hoped that in time some cheaper way may be found out. The discovery of the dynamo made possible the electric light and the electric motor.

Electric Light. The electric current which flows so quietly and so swiftly over the wires will produce heat if it meets with any obstruction on the way. Air, being a non-conductor, stops the flow, and if the wire be cut, only a very strong current of electricity can pass over even a very narrow air space. You have to put your finger quite near the knob of the electrical machine before the electricity can leap across to it, and when it does leap through the air space the bright spark which you see is not the electricity but the heat produced in its passage. If the current is made to pass through some substance which will not melt it will raise the heat in that substance to such a height that it will glow, and give out a brilliant white light, called the electric light. So the electric light does not come from electricity itself, but from heat produced by electricity. After many experiments it has been found that CARBON is the best substance to heat, and it is used in some form in all electric lamps. There are two principal kinds of electric lamps, the "arc lamp" and the "incandescent lamp." The arc lamp is so called because its light is produced by heat from the voltaic arc.

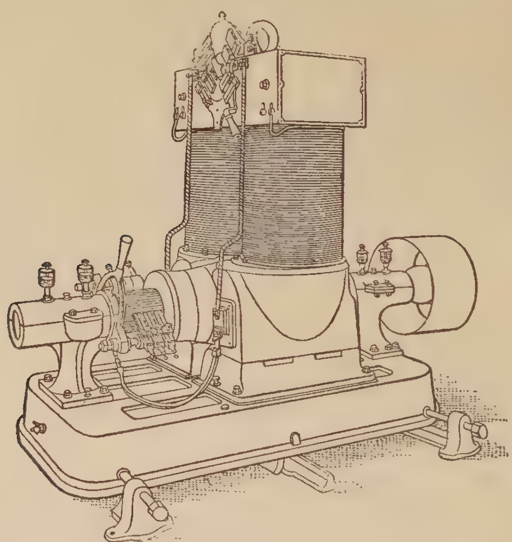


Fig. 8.—Dynamo.

About 1808 Humphry Davy found out that when the electric or voltaic current is made to pass through two pieces of charcoal (carbon) separated very slightly from each other, the charcoal becomes heated white-hot, and if the pieces are then drawn gradually apart the current of electricity keeps flowing between them,

forming a brilliant white arch or arc of light. This arch, called the voltaic arc, was the beginning of the electric light, but no method of using it was found out until 1849, when Foucault in Paris made the first machine to regulate the distance between the two pieces of carbon. Duboscq perfected it, and thus made the first electric light. Since then many different regulators for electric lights have been made in Europe by Serrin, Gramme, Ferranti, Gérard, Bardon, Pilsen, Létang, Puydt, Pieper, Siemens, and Alioth, and in the United States by Brush, Weston, Thomson, Houston, and Sperry. But the lights themselves are formed on the same principle. In all, sticks or rods of carbon in some form are used, and they differ from each other only in the way the two rods are kept at the right distance apart. As the rods burn away slowly, one of them is made to move gradually toward the other so that the arc will always be the same, for on this depends the steadiness of the light.

The working of the Brush light, the one commonly used in the United States for street lighting, is shown in the picture, where the upper and lower rods of carbon can be seen in the globe. In the box shown above the lamp is an electro-magnet, which draws up a plunger of soft iron when excited by the electric current. The lower part of the plunger is connected by a small rod with the holder of the upper carbon rod, as can be seen through the side of the cylindrical case just above the globe. When the electric current flows freely the carbon points become red hot and at the same time the plunger is drawn upward. This draws up with it the upper carbon rod, separating it from the lower one, and thus the voltaic arc is formed between the two points. The air space between is heated and is filled with carbon in a gaseous state which becomes white hot and gives off a dazzling light. The upper carbon, from which the current flows, gradually burns away and forms a little crater of great heat and brilliancy, which acts as a kind of reflector to throw the light downwards. As the carbon burns away

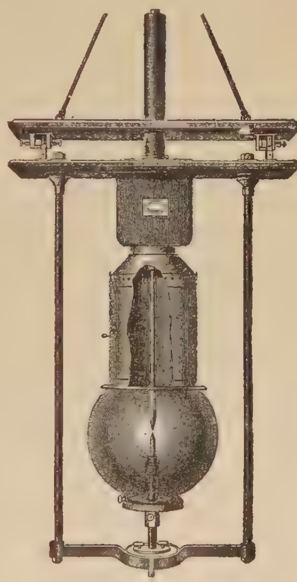


Fig. 9.—Brush Arc Light.

the voltaic arc becomes longer; this makes the electric current weaker and lets the plunger come down, thus shortening the arc and restoring the strength of the current. This method generally works well, but it cannot always be depended upon, and so it is not used where a steady light is a necessity. In lighthouses, for instance, where it would not do to have a flickering light, the carbons are moved by clockwork. The common street electric lamp gives a light equal to about eight hundred candles; but by increasing the size of the carbon rods the power of the light is increased. The great electric lights used in lighthouses have a power equal to many hundred thousand candles, and this power

may be increased to almost any amount.

Another kind of electric light, called the incandescent lamp, is of even greater importance than the arc lamp, because it has more uses. It consists of a thin slip of carbon, enclosed in a glass globe from which the air has been pumped out, the ends of which are connected with wires so that a current of electricity may be passed through it. When the current is strong enough the slip of carbon becomes white hot or incandescent (Latin *incandescere*, to become hot), and gives a brilliant light. There are many kinds of incandescent lamps, but they are all much alike in principle and differ chiefly in the way the carbon slip is made. The first incandescent lamp was made by Edison in 1880. Other kinds are the Woodhouse and Rawson, Swan, Lane-Fox, Gérard, Cruto, Thomson-Houston, Heisler, and Bernstein. The two most used in the United States are the Edison and the Swan lamps. In the former, a picture of which is given, the carbon slip, A, is made of a kind of grass brought from South America which, when carbonized or burned to charcoal, Edison has found by many experiments to be the best for the purpose. In the Swan lamp, which is more elegant than any other, the carbon is made from cotton thread.

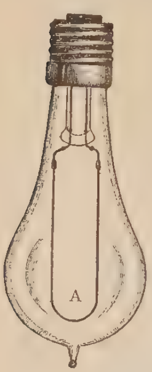


Fig. 10.—Edison Incandescent Lamp.

There are still other forms of electric lights and new kinds are being made all the time, but these two kinds are the ones in common use. The arc lamp is most used in the open air, where a very strong light is wanted, but the incandescent lamp is generally used in buildings and in places where a weaker light is preferred. The incandescent lamp, too, is less dangerous than the arc lamp because the current needed is not so strong. The electric light is now used on ships, in lighthouses, in mines where fire-damp makes the use of common lamps very dangerous, and even under water for exploring the bottom of the sea. Before its invention ships could not go through the Suez Canal by night, but since 1886 vessels fitted with electric lights have been permitted to pass through, thus saving much time. Little electric lamps are used by physicians and surgeons to light up the inner parts of the human body, and by their means small photographs of diseased parts which cannot be seen by the eye are easily made. It is also used in photography—for photographs may be taken by the electric light almost as well as by sunlight. It has been found out, too, that plants grow as well by electric light as by sunlight, so that in greenhouses fitted with electric lights, flowers and fruits grow by night as well as by day and ripen much sooner than in greenhouses without lights, where plants rest at night. The beautiful effects in theatrical scenes are generally produced by electric lamps, the light from which may be made of any color by the use of different glass slides, and thrown upon the scenery by reflectors. Fountains are often lighted by night in a similar way, so that the falling waters show all the colors of the rainbow. Plans have been made, too, for lighting large cities by means of an immense electric light of the power of several million candles placed on a high tower, and this will probably be done when some cheap way of getting electricity shall be found out. A large electric light, too, is to be placed on top of Mount Washington, which can be seen from Portland, and even from vessels at sea.

Electric Motor. To understand the electric motor it is necessary to know first that electricity is not in itself a source of power, but only a means of carrying power from a machine which makes it, such as a steam engine or a water wheel, to another machine which uses the power. Just as the leather belt connects the great wheel of the steam engine with the shaft at a distance and carries to it the power got from the engine, so electricity carries the power which it gets from the dynamo turned by the steam engine and causes it to work the motor at a distance. The power carried by the belt is always mechanical power, that is—machine power; that carried by the electricity is electrical power, which is changed into mechanical power in the motor, and thus enables the motor to do work like any other engine. The belt can carry power only a little way, but electricity can carry it almost any distance, even hundreds of miles, by means of copper wires. At the Frankfort Electrical Exhibition in 1891, the machinery was run by electric power brought from the falls of the Neckar at Lauffen, Wurtemberg, 108 miles away; and it is proposed to lay from Niagara Falls to Chicago, 475 miles, a large copper wire to carry power enough for all the machinery, lights, etc., used at the Columbian Exposition. A company is already at work to carry the power to Buffalo, which, if successful, will enable that city to give up steam power and will make it one of the great manufacturing centres of the country.

The electric motor is then a machine in which electrical power is changed into mechanical power, so that it becomes a motor, that is, am over (Latin *movere*, to move). There are many kinds of motors, some very small and some large enough to run a locomotive engine.

The small ones, from one-tenth to one-half a horse power (see STEAM ENGINE), are used for light work, such as running sewing machines, pumps, turning-lathes, coffee mills, ventilating fans, and other machines used in houses. Most of these get their power from the electric light conductors, but in many cities it is furnished by wires from central stations, where the electricity is made by dynamos worked by steam engines. Large motors, from five up to fifty horse power, are used for working printing presses, elevators, heavy pumps, and other machines for which steam engines were formerly used. Organs in churches are now worked largely by electricity, the bellows being pumped by a motor. In large churches, too, the keyboard is generally connected with the pipes by the electric wires so that the organist may be at one end of the church and the organ at the other. Two or more organs may be connected in this way and played at the same time by one organist with a single keyboard. Before many years it is probable that every city and even every small town will have its power centre connected with the houses by wires, which will do by day all the work that can be done by machines, and will furnish the light by night. The most important use of the electric motor is the driving of locomotive engines on RAILROADS. In the steam locomotive the power is made by the engine itself, but as electrical power may be carried any distance by means of metal conductors and supplied even to cars in motion, the electric locomotive may be driven by power made at the end of the railway line. Small motors are used, too, to drive carriages and bicycles on land, and canoes and launches on water, and some think a way will yet be found out to propel large vessels by electricity.

The **Electric Bell,** one of the simplest forms of an electric motor, gets its power from a voltaic battery. When the button is pressed by the finger the electric circuit is completed, and the current flows around

the coils of an electro-magnet, which attracts a piece of soft iron fastened to a lever, at the other end of which is a hammer that strikes the bell.

Electricity in War. Electricity is used in warfare for military telegraphs, by means of which all parts of a battle-field, sometimes extending for miles, are connected with the headquarters of the commander, who is thus able to follow the movements of his troops. Balloons, too, sent up to spy out the enemy's movements, are connected by a telegraphic wire with the ground. Submarine and subterranean mines are now fired by electricity, and TORPEDOES are guided and exploded by it. By means of the incandescent light electric signals may be made by night between distant points on land and between ships at sea. All naval vessels are now fitted out with a full electric plant, both for lighting, for ventilating, and for doing much work formerly done by hand or by small steam engines. By means of the search light, in which, by reflectors, the light is thrown to a great distance, things a mile away are made visible in the darkest night, so that it is very difficult for boats or torpedoes to get to a ship unseen. Search lights are used too in forts to watch for attacking vessels or storming parties, and on the battle-field to look for the wounded at night. Electric motors are now used on ship to move, load, and fire heavy guns. In old times heavy guns were managed by the united strength of many men, then hydraulic machines were brought into use; but now one man can manage the heaviest gun by moving a small lever. By means, too, of a simple machine called a range-finder, the exact distance of a ship can be found out at once, and telegraphed to the gunner, so that he can tell how to aim his gun. This works on the principle that if one side and two angles of a triangle are known, the other sides and angle can be told. Two men are stationed a certain distance apart, one in the bow and one in the stern, who all the time look through telescopes at the ship, moving their telescopes as the ship moves. A third man, by watching a little instrument, can then read off the distance of the vessel at any time. Another electric instrument, called a position-finder, will tell the exact position of a vessel, so that guns can be aimed and fired at it even when the smoke is so thick that the gunners cannot see it. As soon as the instrument tells the gunner that the gun is aimed right, he presses a button and electricity fires it.

Measurement of Electric Power. In order that we may know the power of an electric motor, it is necessary to have some standard to compare it with, just as we compare the force of steam with horse-power. Previous to 1884 various methods were in use, but in that year a general system was adopted by the International Electric Congress. In this system the amount of electrical force necessary to produce a current of a certain strength is called a *volt*, after Alessandro Volta, the discoverer of voltaic electricity. The current thus produced is called an *ampère*, after André Marie Ampère, a noted French electrician; and the resistance which the current meets with, an *ohm*, after Dr. G. S. Ohm, who was the first to make known the law governing such resistance. An electric force of one volt producing a current of one ampère in a circuit having a resistance of one ohm makes a certain amount of electric power called a *watt*, after James Watt, the inventor of the steam engine. Now, as 746 electric watts are equal to one horse-power, we can tell exactly how much power there is in one watt. The volt is therefore the unit of electric force, the ampère the unit of the electric current, the ohm the unit of electric resistance, and the watt the unit of electric power or work.

ELEMENTS, simple substances which cannot be divided into other substances. Water looks to the eye like a simple substance, but the chemist has found out that it can be separated into two things, OXYGEN and HYDROGEN. No way has yet been found out to divide oxygen or hydrogen, and they are therefore called simple substances or elements. By thus dividing things into their elements, which we call analyzing them, chemists have found out that the many thousand different things in the world may all be separated into seventy-two elements. As chemists are all the time finding out something new about things, it is possible that this number may be added to; and some scientific men believe that there are not so many elements, but that when we know more about things many of those now called elements will be divided and found to be only different forms of other elements.

Classification of Elements. The elements may be divided into two general classes on account of two kinds of properties they possess which are the opposite of each other: when mixed with hydrogen and oxygen, one of these classes forms ACIDS and the other BASES. We are thus able to divide them into acid-forming elements and base-forming elements. The base-forming elements are generally called metals, and the acid-forming elements non-metals or metalloids. The union of acids and bases forms SALTS. The line between these two classes cannot be drawn very sharply, for there are some elements that form both acids and bases. In the following table of the elements, those classed as non-metallic elements are marked with a star (*). A few of these, like antimony, form bases also, and might be classed therefore among metals, but such elements are generally put with the class to which they are related the closest.

TABLE OF ELEMENTS.

ALUMINUM,	*HYDROGEN,	Ruthenium,
*ANTIMONY,	Indium,	Samarium,
*ARSENIC,	*IODINE,	Scandium,
BARIUM,	IRIDIUM,	*Selenium,
*BISMUTH,	IRON,	*SILICON,
*Boron,	Lanthanum,	SILVER,
*Bromine,	LEAD,	SODIUM,
CADMIUM,	Lithium,	Strontium,
Cæsium,	MAGNESIUM,	*SULPHUR,
CALCIUM,	MANGANESE,	Tantalum,
*CARBON,	MERCURY,	*Tellurium,
Cerium,	Molybdenum,	Terbium,
*CHLORINE,	Neodymium,	Thallium,
CHROMIUM,	NICKEL,	Thorium,
COBALT,	*NITROGEN,	Thulium,
Columbium,	Osmium,	TIN,
COPPER,	*OXYGEN,	Titanium,
Erbium,	Palladium,	TUNGSTUN,
*FLUORINE,	*PHOSPHORUS,	URANIUM,
Gadolinium,	PLATINUM,	Vanadium,
Gallium,	POTASSIUM,	Ytterbium,
Germanium,	Praseodymium	Yttrium,
Glucinum,	Rhodium,	ZINC,
GOLD,	Rubidium,	Zirconium.

Some of the elements are very abundant and some are very scarce. Including the atmosphere and the ocean, the mass of the earth's crust is made up chiefly of thirteen of them, namely oxygen, hydrogen, nitrogen, carbon, chlorine, sulphur, aluminum, calcium, magnesium, iron, potassium, sodium, and silicon. Some, like fluorine, manganese, lead, and phosphorus, are pretty common, but others, like gallium, indium, and germanium, are very rare.

Classification by Families. The elements are divided also into families according to the similarity of their chemical properties or the things of which they are made up. Thus, chlorine, bromine, iodine, and fluorine are classed together as the chlorine family, because they resemble each other very closely. Hydrogen stands alone by itself, because it is unlike any other of the elements. Oxygen, too, differs in some things from any other of the elements, but as it shows a resemblance to sulphur in some ways it is generally put in the sulphur family. In the following list of families the non-metallic or acid-forming elements are placed first and the metallic or base-forming elements last.

NON-METALLIC FAMILIES.

Chlorine Family. Chlorine, bromine, iodine, fluorine.
Sulphur Family. Oxygen, sulphur, selenium, tellurium.
Nitrogen Family. Nitrogen, phosphorus, arsenic, antimony.
Carbon Family. Carbon, silicon.

METALLIC FAMILIES.

Potassium Family. Lithium, sodium, potassium, rubidium, cæsium.
Calcium Family. Glucinum, calcium, barium, strontium.
Magnesium Family. Magnesium, zinc, cadmium.
Silver Family. Silver, copper, mercury.
Aluminum Family. Aluminum, the only well-known member; but allied to it are: gallium, indium, thallium, scandium, yttrium, lanthanum, and ytterbium.
Iron Family. Iron, cobalt, nickel.
Manganese Family. Manganese.
Chromium Family. Chromium, molybdenum, tungsten.
Bismuth Family. Bismuth.
Lead Family. Lead, tin, titanium, zirconium, cirium, thorium.
Palladium Family. Palladium, ruthenium, rhodium.
Platinum Family. Osmium, iridium, platinum, gold.

Solids, Liquids, and Gases. Some elements are solids at the common heat and pressure of the air, some are liquids, and some are gases; but by changing the pressure and the heat any one of them may be made to take another form. To understand this, it is necessary to know what a solid, a liquid, and a gas are. The earth on which we stand is a solid, the water which runs on the earth is a liquid, and the air which surrounds the earth is a gas. A solid body is one which does not change its shape or size from its own weight: thus a piece of iron, stone, or wood will keep its shape if left alone, because the particles of which it is made up stick together closely. In a liquid body the particles stick together only slightly, so that its own weight will make it change its shape; thus, if you drop water on the floor it will not stay together like a solid, but its own weight will cause it to spread out in all directions. A gas is a body whose particles do not stick together at all, but repel or push each other away; when a little gas is put into an empty vessel it will spread itself until it fills the whole vessel. Thus a gas will not settle down in a bottle or jar so as to have a level surface like a liquid, but always shows a strong desire to fill any vacant space, and will spread itself out very thin in order to do so. A gas, too, may be squeezed into less space, but a liquid cannot; a gas which fills a quart bottle may be pressed into a pint bottle, and even a smaller one if force enough be used, but a liquid cannot be forced into a vessel smaller than its bulk.

Of the elements given in the table, oxygen, hydrogen, nitrogen, and chlorine are gases at the common heat and pressure of the air, mercury is a liquid, and the others are solids. But if the gases be put under great pressure and a great deal of heat be taken from them at the same time, they can be forced to take the form first of liquids and then of solids. Mercury, too, can be made into a solid by taking its heat from it, so that it may be hammered out like lead; and if heat be added to liquid mercury, it will become a gas. It is the same with the solid elements; they may easily be made into liquids and gases by adding to their HEAT.

The elements are found both as elements—that is, in the free state, or not united with each other—and as compounds, in which two or more are united together. For instance, the oxygen in air is in the free state, being only mixed up with the nitrogen and not united with it; but the oxygen in water is united or combined with hydrogen in such a way as to make a substance entirely different from either of them. A substance thus formed by the union of two or more elements is called a compound substance. Coal gas is a compound substance, because it is made up of hydrogen gas and carbon; and common salt is also a compound substance, because it is made up of chlorine gas and the metal sodium. By continual trying

chemists have found out that everything on the earth, above the earth, and below the surface of the earth, including everything that grows, whether plants or animals, is made up of some of the elements, united in different ways. Some of the principal compounds of elements are told about in the articles, METALS, ACIDS, BASES, ALKALIES.

There are in the world three great classes or divisions of things, usually called kingdoms: the mineral, the animal, and the vegetable kingdoms. All the simple substances or elements belong to the mineral kingdom, and also all compound substances which do not grow. Thus water and air are included in the mineral kingdom. Of things which grow, all ANIMALS are included in the animal kingdom, and all PLANTS in the vegetable kingdom.

The word element is from the Latin *elementum*, a simple substance,

ELEPHANT, the largest and heaviest of land animals. The elephant is usually about eight feet high at the shoulder, but is sometimes twice as high as a man. It becomes full grown when about thirty years old, and lives 120 to 150 years. The weight of a large elephant is about 10,000 pounds, which is equal to the weight of five common cartloads of coal. It is a very clumsy and heavy animal to look at, but can run very fast, and go up and down quite steep hills. Its gait when going fast is neither a trot nor a gallop, but a kind of shuffle. It can also swim very easily and for a long time. In crossing rivers very young elephants often scramble on to their mothers' shoulders, and hold on with their legs.

The elephant's head is very large, but its neck is so short that it could not reach its food or drink without its trunk. The trunk or proboscis (Greek *pro*, before, and *boskein*, to feed or graze) is really a long nose, but, though it can be used for smelling, its chief use is to feel and to pick up things. It is four or five feet long, and is mostly made up of MUSCLES so that it may be lengthened, shortened, or bent in any way. It has two tubes through it, which connect with the nostrils, but which

Head of Asiatic Elephant.

may be shut off from them when the animal wishes. On the end is a small finger-like feeler, with which it can pick up objects as small as a pin. The elephant gathers its food with the trunk, and puts it into its mouth with it. By sucking the air out the tubes can be drawn full of water, which is then poured into the mouth and drunk; or the trunk can be turned upward and the water blown over the back for a bath. It is also through the trunk that the elephant sends out its trumpet-like voice. The trunk is thus at once a nose, a hand, a trumpet, and a suction- and a forcing-pump. It is also a very strong weapon of defence.

The tusks of the elephant are really two long teeth, and grow out of the

upper jaw, one on each side. They are sometimes nine feet long, and weigh more than a heavy man. Both the male and female elephant have tusks, but those of the males are much the larger. The tusks are used to root up the ground, to tear climbing plants from trees, and by tame elephants to move stones, timber, and other heavy things. The tusks are of IVORY covered with a very hard enamel.

The food of the elephant is wholly vegetable, being chiefly grass, the leaves of trees, and roots. Elephants do much damage to the forests in which they live, by breaking down young trees and branches to get the leaves. They usually go in herds, feeding at morning and evening, and keeping in the shade during the midday heat. Their eyes are small, but their senses of smell and of hearing are very sharp, and they are easily alarmed at the sight of men. On the coming of danger they go into the deep woods, but if attacked they turn and defend themselves with great fury. The elephant often fights with the tiger and the rhinoceros, and, though generally the victor, is sometimes killed by the rhinoceros' horns.

There are two kinds of elephants, one of which belongs in Asia and the other in Africa. The Asiatic elephant is smaller than the African. All the tame elephants that we see are of the Asiatic kind; they are brought mostly from India, where they are largely used in travelling, and in hunting tigers. They are usually brownish gray, but yellowish white ones are sometimes seen. In Siam the white elephant, which is an ALBINO, is a sacred animal, and is treated with the greatest respect. The African elephant is known by its enormous ears, which are three times as large as those of the other kind. It is wilder and fiercer than the Asiatic elephant, and is not now tamed, but in ancient times was used by the Carthaginians in their wars against the Romans. It is hunted chiefly for its tusks, which furnish most of the ivory of commerce, and many thousands are killed yearly.

The Arabs, who are the principal elephant-hunters, usually go after them on horseback, but often on foot. Those who hunt on foot follow the tracks of an elephant so as to come up with it near noonday, when the animal is usually asleep or lying down to rest. If one is found asleep, a hunter creeps up to it through the grass and cuts off its

Head of African Elephant.

trunk with his sword. When the elephant feels the blow it jumps up on its feet, but it is so confused that the hunter gets away, and the elephant bleeds to death in about an hour. If the animal is awake, the hunters creep up behind and cut the sinews of one of the hind legs above the heel. The elephant cannot then step upon his leg, and so cannot run after them. They soon cut the cord of the other hind leg, when the animal falls down, and they then cut an artery and let it bleed to death.

When the Arabs hunt on horseback they chase the animals until they get angry and turn upon them. One of the hunters then lets an elephant almost catch up with him, keeping his horse running just fast enough to escape the animal's trunk, with which it tries to seize the horse. The elephant's mind is so taken up with chasing this one that it does not notice the others who ride up behind. As soon as one of them gets near enough he jumps off his horse, and seizing his sword with both hands cuts the cord of the elephant's hind leg. He then jumps on his horse again The elephant is made almost helpless by the cut, but tries to make another rush on three legs, when the hunters cut his other leg, and he falls down and dies from loss of blood. This kind of hunting is very dangerous, and the hunters are often caught and killed by the elephants.

Sir Samuel Baker says that the Arabs are very fond of elephants' flesh, which is generally fat and juicy, though coarse and with a strong smell. The trunk and the feet, which are the best parts for eating, he found very good when well cooked. To cook one of the great feet, a hole nearly a yard wide is dug in the ground, and filled with wood, which is kept burning until the sides of the hole are very hot. When the blaze has gone out the foot is laid upon the coals, and the hole is then covered over with green wood and wet grass, plastered with mud, and stamped down tight. Earth is then piled over it, so that all the heat will be kept in, and it is left for a little more than a day and night. When opened the foot is found so well baked that the whole sole comes off like a shoe, leaving enough tender, juicy meat inside to feed fifty men.

The elephant is a MAMMAL of the order *pachydermata*, or thick-skinned animals.

The word elephant is from the Latin and Greek *elephas*.

ELEVATOR. Since the introduction of elevators or lifts to raise passengers and freight from lower to upper stories, much higher buildings have been built, and upper floors have been put to uses which would before have been impossible. Buildings ten and twelve stories high are now common, and some of even fifteen and twenty stories have been built. All the best hotels, office buildings, apartment houses, and other structures are now furnished with both passenger and freight elevators. Many of the passenger elevators in use in New York, Chicago, and other great cities are very handsome, being built of mahogany and other costly woods, finely decorated and upholstered.

The earliest form of elevator was a simple platform for freight, worked by ropes pulled by hand. This was next made into a car, as now, worked by steam, water-power, or electricity. In steam elevators the ropes that lift the car are wound round a drum turned by a steam engine. In the hydraulic or water-power elevator the ropes are connected with a motor worked by water; but it is necessary to have a steam pump to lift the water to the tank at the top of the building. Hydraulic elevators are generally cheaper than steam and are most used, but it is probable that electricity will soon take the place of both. Elevators are worked, too, sometimes by pneumatic power or compressed air.

Railway Passenger Elevators. Passenger elevators are used also at railway stations. The Manhattan Elevated Railway in New York has one at the 116th Street station; but this is small compared with that of the North Hudson County Railway at Weehawken, opposite New York. The latter is in a great steel tower, 45 feet by 60 feet square, and 197 feet high. There are three elevator

cars, each 21 feet 6 inches long by 12 feet 6 inches wide, and 10 feet high, each suspended by eight steel cables. Each elevator will carry 135 passengers, or 400 in all three, every trip. Steamboats land passengers at the base and they are carried up the elevators directly to the cars, which run out on the viaduct connecting the elevator with the top of the bluff at Weehawken, and thus save a long tiresome journey up the hill. These elevators, which are worked by hydraulic power, are the largest in the world. The next largest are the Mersey Tunnel passenger elevators at Liverpool, which carry about half the number of passengers.

Industrial Elevators. Many kinds of elevators are used in different trades and industries. The common platform elevator, worked by steam or hydraulic power, is used in warehouses and factories. An elevator consisting of an endless iron chain to which hods can be fastened by a hook is much used for carrying bricks and mortar to workmen at the top of buildings. The empty hods come down on the opposite side of the chain. Some elevators work on an incline by means of an endless rope or chain drawn by a steam engine. Such ones are used in coal mines, iron works, ice-houses, factories, etc. Large elevators working on this principle are in use at Rondout, New York, where they unload barges laden with coal from the Pennsylvania coal fields, and reload the coal on outgoing barges on other vessels. The endless cable or chain carries buckets which are continually passing filled with coal and unloading at the other end.

Grain Elevators. In the United States this name is generally given to the building in which grain is stored, as well as to the elevators which lift and convey the grain. These buildings are by the water's edge so that vessels may come up to them to receive cargoes; and have tracks for railway cars running into them on the other side, to receive the grain. The grain is shovelled from the cars into receiving pits, from which it is raised by buckets fixed on an endless belt to the top of the building. There it is stored in bins, with bottoms like a hopper, so it will run out easily. It is weighed when taken in and when sent out. There are immense grain elevators in cities where grain is shipped. One of the largest, at Minneapolis, Minnesota, is 336 feet long, 92 wide, and 175 feet high, and will hold two million bushels of grain. A still larger one, at Chicago, is 550 feet long and 156 feet high, and will hold two and a half million bushels. It can unload 500 cars a day and deliver 100,000 bushels an hour to cars and boats. In 1891 New York had 27 grain elevators, Chicago 26, Minneapolis 16, Duluth 14, St. Louis 12, Milwaukee 9, Detroit 4, and Peoria 5. Floating elevators, or elevators erected on vessels, are used in some places for transferring grain from barges to the holds of ships.

The word elevator is from the Latin *elevare*, to lift up.

ELK. See DEER.

ELM a tree common in the United States, and in most cool countries. The white or American elm, found in all the Northern and Middle States, and as far south as Georgia, is one of the most beautiful trees in the world. It grows very high, with many wide-spreading branches, and its trunk is usually clothed with small leaf-covered twigs. It is one of the finest of shade trees. Its branches often lock together so as to make beautiful arches overhead, like those in Gothic churches. Cattle yokes, BLOCKS for the rigging of ships, and hubs for wheels are made from its timber.

The slippery elm, sometime called the red elm on account of the color of its buds, is a smaller tree than the white elm, but has more beautiful leaves. Its inner bark is full of

a kind of mucilage; it is dried and much used in medicine in cases of catarrh, dysentery, etc. The wahoo or winged elm is found in the Southern States. Its wood is valuable. The English elm, a beautiful shade tree, and the wych elm, sometimes called the Scotch elm, have been planted in this country, and grow well. Elm bark is used in tanning, dyeing, and in sugar refining.

The word elm is from the Anglo-Saxon *elm*, Latin *ulmus*, elm.

EMERALD, a beautiful green PRECIOUS STONE. The true emerald is of a rich green color; when pale bluish green it is usually called aquamarine. The oriental emerald is a green SAPPHIRE. It is among the rarest of all stones, and very few of them have been found. The finest emeralds are found in the valley of Mozo, in the United States of Colombia, South America, and the finest aquamarines are brought from Siberia, Hindostan, and Brazil.

An emerald of fine color and without any flaws sell for a high price; but the aquamarine is not so valuable. Very large ones are often found, some of them a foot long, but their color is usually poor.

The word emerald comes from the Norman French *esmeraulde*, which is from the Latin *smaragdus*, Greek *smaragdos*, an emerald.

EMERY, a hard mineral much used for polishing hard stones, metals, and plate glass. It is found in pieces of all sizes, up to several tons weight. The stone is crushed under stamps, and sifted into powder of different fineness. Emery paper, emery cloth, and emery sticks, used for polishing different things, are made by covering paper, cotton cloth, and slips of wood with glue and then sifting emery powder on them. Razor-strop paper is made by mixing emery powder and ground glass with PAPER pulp, and then rolling it into sheets. Most of the emery used is dug in the island of Naxos in the Grecian Archipelago, and shipped from Smyrna. Much has been found in Massachusetts, North Carolina, Georgia, and Montana.

The word emery is in French *émeri*, and is from the Greek *smuris*, emery.

ENAMEL, a glassy substance used for painting on glass and porcelain, and for covering metals. There are two kinds, thin and thick enamel.

Thin Enamel, sometimes called surface enamel, is generally put on like a paint, with a camel's hair pencil, and the article is then heated hot enough to melt the enamel, which is thus fastened on so as to become a part of the surface. The pictures on pottery and porcelain are made in this way. The most difficult part of the work is the baking, which has to be watched with the greatest care, because if the oven gets too hot the colors will run together and spoil the picture.

Enamelling on metal is still harder than enamelling on porcelain or on glass, because the metal sometimes spoils the colors. For this reason gold is better to enamel on than silver or copper. Beautiful pictures are sometimes enamelled on metals, and fine jewelry is made by covering gold with different colored enamels put on in ornamental patterns. But the largest use of enamel is to cover the inside of metal wares, such as saucepans and basins, to keep them from rusting. The surface is first cleaned with weak acid, and wetted with gum-water; the enamel, made of powdered glass, BORAX, and SODA, is then sifted on as a powder. When heated in an oven this melts and covers the surface of the metal with a thin white glaze. Watch dials are made in a like way. The round disks are cut out of thin sheet copper, and after being shaped right are covered with a white enamel. This is carefully baked, and when finished the hour figures and other marks are painted on with black enamel, which also is baked until it becomes a part of the whole.

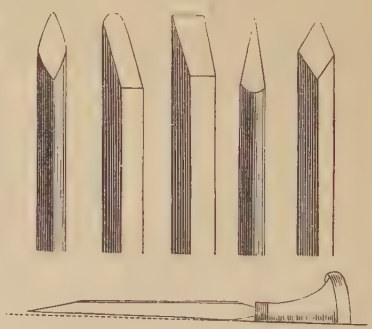
Thick Enamel, sometimes called enclosed enamel, is more like a paste than a paint, and is spread thick so as to fill up enclosed places. Among the principal thick enamels is that called *cloisonné*, from the French word *cloison*, a partition. In this all the lines of the design are built up with thin metal partitions, made of a kind of square wire, so that the whole picture appears raised above the surface. The spaces between the partitions are then filled with enamel, which is colored glass ground to powder, and mixed with enough gum and water to make a paste of it. When all the parts are filled with the right colors to make the design, the piece is baked in a furnace. As soon as the enamel melts enough to become glassy, the piece is taken out and left to cool. As the enamel when melted takes up much less room than when powdered, the parts have to be filled up again and again until the melted enamel is even with the tops of the metal partitions. The surface is then ground down smooth, when all the parts of the picture are seen divided by the metal cloisons or partitions. Cloisonné ware was probably first made by the Chinese, from whom the Japanese learned the art toward the end of the sixteenth century. When the English took Pekin in 1859, they found in the Summer Palace cloisonné enamels on copper five to six hundred years old. In Japan the principal cloisonné workshops are at Nagoya, where the business has been carried on more than three hundred years.

Another way is to cut out places for the enamel in the metal, instead of building up partitions above the surface. This is called by the French *champlevé*.

The word enamel is made of *en*, in, and the Old French *esmail*, enamel.

ENGRAVING. There are two principal kinds of engravings, wood or block engravings, usually called wood-cuts, and plate engravings. Wood engravings are printed with wooden blocks, and plate engravings with metal plates.

Wood Engraving. Blocks for wood engravings are usually of BOXWOOD, and are made just the height of a TYPE, because they are used mostly with type in printing the pages of books. The surface of the block, which is made very smooth, is first covered over with a thin layer of white chalk mixed with gum-water. The artist draws his picture on this, partly with a lead pencil and partly with a brush and India ink. The block now goes to the engraver, who cuts out of the wood, with fine sharp tools, all the spaces between the lines of the drawing, leaving the lines themselves just as the artist drew them. The drawing is thus left in relief, that is, standing up like the face of a type, so that when the block is used in printing the raised lines make a picture just like the drawing. Several kinds of tools are used, some with sharp points, some with square, and some with round edges, as shown in the picture. At the bottom is one of the tools with the handle on.

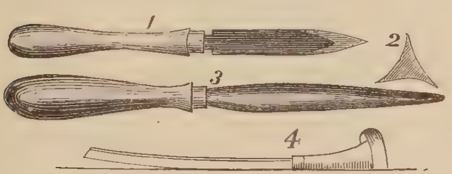


Wood Engravers' Tools.

Plate Engraving. The picture from an engraved plate is just the opposite of this. The lines themselves are cut or sunk into the plate, leaving the spaces between them as

they were. When the plate is used to print with, it is inked all over, and the ink is then rubbed off from the surface with a cloth. This leaves all the lines full of ink; and it is these sunken lines which print the picture when a sheet of paper is pressed down on to the plate. Printing engravings from plates takes much more time than printing from wood blocks. They have to be done by themselves, and therefore cannot be printed on the same press with the letter-press or type part of a book.

The metals most used for making plates for printing engravings are copper and steel. Copper is much softer and more easily cut, but steel lasts longer, and is therefore much more used for fine pictures. Maps are now almost the only kind of engravings made from copper plates, but a kind of outline pictures called etchings are also usually printed from copper plates, although steel and glass plates are sometimes used. Copper was used for making all plates until this century, when an American named Jacob Perkins found out how to soften steel by taking the carbon out of it, so that it is almost as easy to cut with the engraver's tools as copper, and then to harden it again after the picture has been cut on it.



Steel Engravers' Tools.
1, Scraper; 2, End View of Scraper; 3, Burnisher; 4, Burin.

The art of cutting the lines on a plate from which an engraving is to be printed is called engraving. The process is nearly the same on both copper and steel plates. There are several kinds of engraving, the principal of which are line, stipple, and etching. In line engraving the lines of the picture are cut into the plate with a tool called the burin or graver. The burin has a sharp triangular or three-cornered point, as shown in the picture (4), which cuts a clean line out of the plate without leaving any rough edge. Several kinds of burins with points of different width are used, Very fine lines are made with another tool called the dry point. This is round and sharp like a darning needle, and leaves a burr or rough edge along each side of the line it cuts, which has to be scraped off with a tool called a scraper (1). The scraper is three-cornered, as can be seen by the end view (2). Another tool called a burnisher (3) is used to soften lines cut too deep and to rub out scratches in the plate. In stipple engraving the picture is shaded by means of little dots, cut close together in the plate, instead of lines. The larger dots are made with the burin, the smaller and finer ones with the dry point. Stipple engraving is much used in making portraits and pictures of sculpture.

Etching is a kind of engraving done partly with tools and partly by means of an ACID. A copper plate is varnished over with a thin film or coat of wax and ASPHALTUM. When it is dry the etcher makes his drawing on it with etching needles or points, which are simply needles of different sizes set into handles, cutting all the lines through the wax varnish down to the copper. After this is finished a little rim of wax is built up all around the edge of the plate, and weak NITRIC ACID mixed with water is poured all over the face of the drawing. The acid eats into the copper wherever it is laid bare by the lines of the drawing, but does not eat the parts covered by the varnish. In about a quarter of an hour the acid is poured off and

the plate cleaned, the varnish being melted off. The plate is then ready to be printed from like any other plain engraving. When etching is done on glass, another kind of acid. called hydrofluoric acid, is used, because nitric acid will not eat glass.

Almost all engravings are made up partly of line and stipple work, and partly of etching. The outlines of figures and draperies, landscapes and skies, buildings, and animals are usually etched; but they are afterward finished with tools; human figures are generally engraved in lines with the burin, but in cheap engravings they are sometimes done in stipple. Straight lines parallel or running side by side are made by a machine called the ruling machine, which cuts them very true, and either fine or coarse, as wanted.

Mezzotint, or middle tint (from Italian *mezzo*, middle, and *tinto*, color), looks much like a drawing in India ink. This is the opposite of other kinds of plate engraving. In common plate engraving the lines which are to print the picture are cut into the plate, the part of the plate which is left untouched making the light portions of the picture; but in mezzotint the plate itself makes the dark parts or shadows, and the light parts are cut out. The face of the plate is first made rough by running over it a little instrument with teeth, called a cradle. The picture is then made by rubbing away parts of this rough surface with scrapers and burnishers so as to make the lights and shades. Aquatint engraving is another form once much used, but which has now given place to lithography and other methods. (See BANK NOTE and LITHOGRAPH.)

The word engraving is from engrave, which is from *en*, in or upon, and grave, from Greek *eggraphein*, to engrave.

ENVELOPE, a cover or wrapper, usually of a letter. When envelopes first came into use they were made by hand, but now they are made by machines. The sheets of paper are first cut, in piles at a time, by great knives, into pieces a little longer than they are wide. These oblong pieces are next cut by dies of the proper shape in the right form to be folded into an envelope. By opening an envelope and laying it out flat you will see what this form is. Sometimes these blanks, as they are called, are cut directly from the sheets of paper. If there is to be a stamp or device on the flap of the envelope, it is then put on with another DIE.

The blanks are now fed one by one into the folding machine. Each one is carried on to a kind of box of the exact size of the envelope to be made; a plunger, or flat piece of metal made to fit into the box, now comes down and pushes the blank in, making four creases where the four flaps fold over. The two end flaps are then folded down by small pieces of iron, which work like fingers; a gumming machine gums the edges; two more iron fingers fold down the other flaps, but fasten only one of them; and lastly a pusher pushes out the envelope and makes room for another one. All these things are done in one second, so that each machine makes sixty envelopes a minute.

This machine makes only one kind and size of envelope; but a newer machine, on a different plan, can be fitted to make any common size and will fold and gum more than twice as many a minute. The envelopes are delivered in packs of twenty-five on a table in front of an attendant, who has only to put a paper band around them, when they are ready for packing.

Paper Bags, like envelopes, were first made by hand, but are now made entirely by machinery. The American paper bag machine, now largely used in the United States and in Europe, will make bags of various lengths and widths, and out of any kind of paper. The paper of the right width, which is fed to the ma-

chine from a great roll at one end, is gummed along one edge by a roller and then formed into a long tube by pressing the edges together, It is then cut off into proper lengths for bags by revolving knives, and passing on has the bottom cut, pasted, and folded by another part of the machine. This machine, which needs only a young girl to attend it, will make every hour 7000 bags, all dried and ready for use. Paper bags are made of all sizes, some of them large enough to hold a barrel of flour. Paper boxes, too, are made now in a similar way almost entirely by machines.

The word envelope is from the French *enveloppe*, which is from *en*, in, and *velopper*, to wrap.

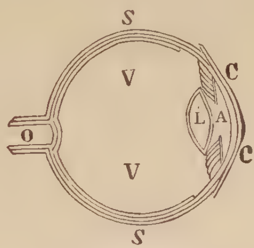
ERMINE, a kind of weasel found in the north of Europe and of Asia. It lives on animal food, such as rats, mice, moles, and other small animals, and birds and their eggs. In summer its fur is yellowish brown, but in winter it is mostly pure white. The tip of the tail is always black. Ermine fur is brought mostly from Siberia, Alaska, Norway, and Lapland. In making it up the black tail-tips are set into the white fur so as to make a regular pattern. It is used for ladies' winter garments, and in some countries for the robes of kings, judges, and other high officers.

The word ermine comes from the Spanish word *armiño*, Portuguese *arminho*, ermine.

ETHER, a light inflammable liquid with a sweetish taste and an aromatic smell, much used in medicine, like CHLOROFORM, to make people insensible to pain. It is made by distilling ALCOHOL with sulphuric acid, whence it is sometimes called sulphuric ether. Ether is very volatile (Latin *volare*, to fly), that is, it passes into gas quickly and flies away. In doing this it causes intense cold; if a few drops are put upon a drop of water and blown on through a tube, the water will be frozen at once. It is sometimes used therefore in making artificial ice.

Ether is from the Latin *æther*, Greek *aither*, air.

EYE. In the article MAN, it is told that there are two rounded hollows called orbits in the front part of the skull, to hold what are commonly called the eyeballs. They are rightly called eyeballs, for when taken out they are seen to be nearly as round as a ball. One of them is shown in the picture, where it is cut down through the middle so that its parts can be seen. In this, S S is a tough skin which goes all round the eye, excepting in front, where there is a round opening in it covered by a very thin clear skin like a watch-glass,



Plan of the Eyeball.

called the cornea, marked C C. Inside the cornea is a space, A, filled with a clear liquid called the aqueous or watery humor.

When you look into an eye, you see in the middle of the white ball a round colored part with a darker round spot in the middle of it. This round part is the iris, and the dark spot in it is the pupil. The pupil is not really a spot but a hole through the iris, and it looks dark because the back part of the eyeball is black. It is like a window looking into a dark room. The iris is of different colors in different people. If a person has a blue iris we commonly say that he has a blue eye, and if a very dark iris, a black eye. But the eye itself is always of the same color; it is only the iris which differs. In the

picture the two little partitions pointing towards A are the upper and lower sides of the iris, and the space between them is the pupil or window opening into the eye.

A little way back of the iris, is a clear jelly-like substance, L, called the crystalline lens. It is shaped like a double convex LENS, but the curve of the front side is flatter than the one behind. Behind this lens the whole inside of the eye, V V, is filled with another clear fluid, called the vitreous or glassy humor, which is a little thicker than the aqueous humor in front of the lens. Inside the tough skin, S S, around the eyeball, is a second coat called the choroid, the inside of which is covered with a very black slime, and over this a delicate thin skin called the retina. The part marked O is the optic NERVE, which enters the eye on the side next to the nose, and which joins the eye with the brain.

The eye is much like the camera, or instrument used by a photographer for taking pictures. When a person sits down before the camera a small image of him is made on a plate in the back part of the instrument by means of the lenses in it, through which the rays of light pass. If there were no lenses no image would be formed, but the whole of the plate would be blackened. It is the same with the eye. When we look at anything, the rays of light from the thing looked at pass through the cornea, and part of them go through the pupil, and through the crystalline lens and the vitreous humor to the back part of the eye, where they fall on the retina. Thus the aqueous humor, the crystalline lens, and the vitreous humor act like lenses and make an image of the thing looked at upon the retina, just as the lenses in the camera form an image on the plate. This image, like the one in the camera, is much smaller than the thing looked at.

If this were all there is to the eye, it would not be of much use to us, for however well it might work we could not see the image made. Seeing is not done by the eye, but by the brain. As told above, the eye is joined to the brain by the optic nerve. The eye makes the image and the nerve carries the sense of it to the brain, and then it is seen. The image itself is not carried to the brain; the nerve only makes the brain know that the image is formed on the retina. As there are two eyes, so there are two nerves, one from each eye, but as each eye makes the same image, so each nerve tells the same story to the brain. If it did not, the mind would see double. We are enabled to move our eyes by means of MUSCLES, which are joined to the brain by motor NERVES.

The eyes of all persons do not see alike; some are near-sighted and some are far-sighted. In a near-sighted eye the lenses are too round, so that the rays of light come together into a point before they reach the retina. Thus, the image being in front of instead of on the retina, is not plainly seen. In the eyes of persons who are far-sighted the lenses are too flat, so that the rays of light would come to a point behind the retina, but as the retina stops them they make a blurred image on it. Near-sighted people hold things near the eye to see them, because the image is then formed further back on the retina; and far-sighted people hold things far off to see them, because the image is then formed further forward on the retina. For the same reasons near-sighted persons wear concave glasses, and far-sighted persons convex glasses. Near-sightedness is sometimes natural, but it is often caused in children by bending over and bringing the eyes too close to the thing looked at. Old people are generally too far-sighted, because the humors of the eye dry up by age, so that the lenses become flattened. For the same reason, the eyes of

near-sighted persons become better as they grow older. Birds of prey can flatten their eyes by means of a muscle which draws back the crystalline lens, so that they can see at great distances; and they have also a kind of bony rim to their eyes by which they can press out the cornea and make it rounder, so that they can see near things clearly.

The iris of the eye is a kind of curtain, which stretches and shrinks, so that the pupil, or opening through it, is sometimes smaller and sometimes larger. In a bright light the iris stretches so as to make the pupil smaller, because too much light pains the nerves; but in the dark it shrinks and enlarges the pupil, so as to let in more rays of light. The pupil is shaped differently in different animals. In the cat it looks like the edge of a convex LENS. When the sun is bright it is very narrow, but in the evening it opens wide. The eyes of owls work in the same way, and this is the reason why they can see so well in the dark. If our pupils opened as wide as theirs at night, we could see as well as they do. Children often strain their eyes by trying to read with too little light. This is a very bad habit, and if done much is sure to injure the eyes. It is also dangerous to have too much light. Children have been struck blind by staring at the sun.

Each eye is furnished with two eyelids, moved by muscles, which shields it from too much light, and keep it from being injured. The eyelashes also help to shade the eyes and to keep out dust. The motion of the eyelids commonly called winking keeps a gentle flow of tears all the time over the eyeball, keeping it moist and carrying off any dust or other matter which may get into the eye. The tears, which come from little bags above the upper eyelid, finally passes into two tubes in the inner corner of the eye, which lead into the nose. When we cry, more tears flow than can pass through the drain into the nose, and so they run over the eyelids and down the cheeks. Tears are therefore useful to the eyes, but too much weeping irritates and injures them.

The eyes are among the most delicate of our organs, and too much care cannot be taken of them. Though they are put in what seems to be a dangerous place, they are so guarded that they seldom get hurt. The parts around them are sometimes bruised, and we then say that the eye is black and blue, but the eyes themselves are seldom struck. This is because they are set in a deep socket, so that they are protected by bone all around them except in front. A blow upon one of them strikes on these bony walls, so that the eye generally escapes injury. The eye has still another guard in being able to wink quickly. When anything harmful is seen coming toward it, the optic nerve tells the brain of the danger, the brain sends a message through some of the motor nerves to the muscle in the eyelid, and that muscle at once shuts down the eyelid. It would seem that this would take a long time, but it is done so quickly that we get from it the common expression "as quick as a wink." When the eye winks, the eyeball is not only shut in, it is moved back a little way in the socket; and at the same time the muscles of the eyebrow and of the face below the eye are drawn together so as to make a kind of cushion which saves the bone from being cracked when a blow falls on it. So the eyes are defended on all sides except directly in front, and this is the reason why this tender organ meets with so few accidents.

Still it is never safe to strike the eyes, and children should be very careful how they aim a blow near them, either in anger or in play, for the loss of sight is a dreadful calamity which can never be cured. The historian Prescott, while a student at Harvard College, had one of his

eyes hit by a crust of bread, which a fellow student threw at him in fun across the table. It was hurt so that he could only just tell the difference between light and darkness with that eye, and the use of the other one alone in his studies hurt that one so that he was nearly blind for several years, and during all the last half of his life he could scarcely see to write at all, and could only read for a few minutes each day.

The word eye is from the Anglo-Saxon *eage*, eye.

F

FALCON. The family of birds of prey called by this name include besides the true falcons, the EAGLES, BUZZARDS, KITES, and HAWKS. The true falcons are found all over the world, and in almost all climates. They are large strong birds, with long wings, and fly very high. Their beaks and talons are curved and sharp, fitted for tearing their prey, which is chiefly other birds, but they attack also small MAMMALS. When chasing their prey they hover over it in the air, and then dart down upon it.

The kind of falcon most common in the United States is usually called the duck-hawk, because it feeds much on wild ducks. It has been seen to pounce down upon a large duck on the wing, and even to carry off a wounded duck within a few yards of the hunter who has shot it. It flies off with its prey to some quiet place, strips the feathers off the breast, and tears off and eats the flesh. It builds its nest of coarse sticks on some high ledge of rocks, and lays reddish brown eggs, splotched with darker brown.

In old times, before gunpowder was known, falcons were trained to hunt other birds, especially the HERON. Falconry, or hawking, as it was usually called, became a favorite sport with kings and nobles, and the grand falconer, who had charge of the king's falcons, was an important person at court. When gentlemen went hawking, they rode out each carrying a falcon on his wrist, the bird's head being covered with a little hood so that it could not see. As soon as any game was found, the hood was taken off and the falcon rose up flying in circles high into the air until it got above the prey, when it swooped down, caught it in its talons, and brought it to its master. After catching a bird the falcon was always given some food, and when it had eaten it was hooded again until more game was seen. This sport was so fashionable in England that persons of rank generally had a hawk sitting on their wrists when they went out, and even now fashionable people sometimes go hawking for amusement.

In Persia the falcon is trained to hunt the gazelle. When a gazelle is seen, two birds are loosed and one of them darts on to the nose of the animal and holds it tight with its talons, flapping its wings so as to blind its eyes. The gazelle stops and tries to shake off the bird. If it gets it off, the other falcon at once seizes it, and thus they take turns, hindering the gazelle's flight until the dogs come up with it. The blue antelope is caught in the same way in India, where parties of ladies and gentlemen ride out on elephants, carrying their falcons with them. The Arabs of the Sahara desert also train falcons to hunt. In China and Japan, too, hawking is a favorite amusement.

The falcons belong to the order *raptores*, or BIRDS of prey.

The word falcon comes from the Latin *falx*, a sickle, the bird's claws being curved like a sickle.

FAN, an instrument for cooling the person by setting the air in motion. Fans have been used from the earliest times by nearly all nations. Ancient kings had fan-bearers, who attended them on almost all occasions, carrying large fans of gay

feathers, with which they shielded them from the sun and cooled their persons. These fans were sometimes borne as standards in time of war. Among the Greeks and Romans fans were mostly carried by slaves, who attended their masters or mistresses with them, and fanned the guests at meals. From the Middle Ages up to the present time fans have been considered articles of necessity as well as of luxury among all European nations, and much taste and skill have been expended on their manufacture.

The most beautiful fans are now made in Paris, Vienna, Brussels, and Geneva, but many very fine and costly ones are made in England and the United States. In Paris there are several thousand persons whose sole business is to make fans. They are divided into four distinct trades, each having its own workshops and workmen, and each making only one part of the fan. Almost all the French fans, from the cheapest to the most costly ones, pass through at least twenty different hands before they are finished; and a great number of materials, including ivory, mother-of-pearl, tortoise-shell, bone, various woods and metals, whalebone, silk, satin, parchment, paper, lambskin, gauze, and feathers, are used in their manufacture. Most of the common fans in use in the United States are made in China and Japan. The cheapest kinds are of palm leaf, and of split bamboo covered with paper. The paper covered ones are made either entirely open, or to open and shut, and are often gaily painted and lacquered or japanned. Many of these are so pretty that they are used to decorate walls, to loop back curtains, to make cornices, etc. The Chinese and Japanese make also expensive fans of ivory, bone, mother-of-pearl, sandal wood, tortoise-shell, and feathers. Chinese ivory fans are sometimes made entirely of ivory, beautifully carved in open work, but they are not so light and easy to handle as those covered with silk or paper.

In China and Japan a fan is carried by gentlemen in the streets, much as a cane is carried by gentlemen in other countries. The pictures painted on their fans often have a meaning, some of them being meant to give information like a newspaper, and some being caricatures of public or well-known people. Chinese and Japanese jugglers are very skilful in using the fan. One of them will sit and calmly fan himself, and at the same time keep in the air a pair of paper butterflies, which will fly round his head with all the motions of real butterflies, now lighting on the edge of his fan or on a flower, and now chasing each other high up in the air, and then coming back to flit round his head again.

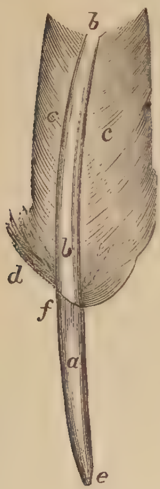
The word fan comes from the Anglo-Saxon *fann*, which is related to the Latin *vannus*, a fan for winnowing or cleaning grain.

FATHOM, a measure of length, containing six feet. It is used chiefly by sailors, especially in sounding the depth of water. It is used also in mining, the amount of ore worked being reckoned by fathoms instead of feet.

Fathom, which is from the Anglo-Saxon *fæthm*, originally meant the space that a man could reach over with both arms extended.

FEATHERS, the covering of birds. All feathers are made alike, in their general form, although they differ greatly in size, strength, and color. Each one has a quill, or barrel, shown at *a* in the picture, a shaft, *b b*, and a vane, beard, or web, *c c*. The quill is a hollow horny tube made of hardened ALBUMEN. It has an opening at the bottom, *e*, and one where it joins the shaft, *f*, and has inside a thin dry core. The shaft is smaller and longer than the quill, and is nearly flat on each of its four sides. It is made of a white spongy substance called the pith, covered with a thin horny sheath.

The vane or beard, which is in two parts, one on each side of the shaft, is formed of many small flat plates or scales, which grow out of the sides of the shaft, and lie with their flat sides close to each other. These sides have along their upper edges little hooks, or barbules, by means of which they hold fast to each other, so that the surface of the beard is close and smooth and does not open when the bird is flying. In some birds, like the ostrich, these barbules do not hook very tightly together, and this makes their feathers more soft and plumy than those of other birds. At the bottom of the beard, next to the quill, there is usually a small feathery tuft, *d*, called the plumule, or accessory plume. Besides feathers, many birds have next to the skin a soft fleecy covering called DOWN, which is made up of very small feathers.



Feather.

Feathers grow very fast, and almost all birds change them every year. Young birds are covered first with down, which gives way to feathers as they grow older, but it generally takes from one to five years before the plumage is fully grown. Feathers vary in size and in form in different parts of the body, and have been given different names by those who write about birds. Most birds have a small gland, or kind of bag, at the base of the tail, from which they squeeze out oil with their bill and spread it over their feathers. This is partly the reason why birds' feathers shed water.

Feathers have three principal uses in the arts: for making PENS, for stuffing beds, pillows, etc., and for ornament. Goose feathers are the best for beds, because they are softer and more springy than others, but turkey, duck, and hen feathers are used for cheap beds. The feathers are better when plucked from the living bird, and geese kept for this purpose are picked three or four times a year. Much preparation is needed before the feathers are fit to put into beds, such as steeping in lime water, washing in clean water, drying, steaming, beating, etc.

Of ornamental feathers those of the OSTRICH are most prized, especially the large white plumes from the back and tail of the male bird; but many other birds, such as the peacock, swan, turkey, pheasant, cock, heron, egret, osprey, eagle, ibis, rhea, emu, adjutant, grebe, marabout, stork, and bird of paradise yield feathers used for ornament. In preparing ostrich plumes for use they are tied up in bundles and washed in warm soap and water to free them from grease. The soap is then washed out in clean hot water, and they are bleached in boiling water into which some Spanish white has been put. After rinsing they are drawn quickly through cold water with a little indigo into it, and are then steamed over sulphur fumes and dried. The shafts are scraped to make them limber, and the filaments or feathery parts are curled by drawing the edge of a blunt knife over them. Other feathers are dressed in a less careful way, and are often dyed of many beautiful colors.

Feathers are largely used for making FANS, and in some countries great fans or screens are always carried by attendants to shade the king. Large fans made of ostrich plumes are usually borne behind the Pope on great occasions. The Aztecs or Mexicans made beautiful robes of colored feathers, and in the Sand-

wich Islands a splendid mantle made of many thousand feathers of the rarest birds was for a long time worn by the king, when he was crowned, and on other great occasions. This costly cloak was buried with one of the late kings. In Arctic countries people make coats out of birds' skins, wearing them with the feathers inside. The Turks and Persians wear egret feathers in their turbans; soldiers wear cocks' feathers in their hats; the Scotch Highlanders wear eagles' feathers in their bonnets; and the Zulus of Africa and the North American Indians ornament their hair with them. Wings and feathers of many kinds of birds are worn by ladies in their hats, and the skins of the swan, penguin, and other birds, with the feathers on them, are used for muffs, dress linings, tippets, cuffs, etc.

The word feather is from the Anglo-Saxon *fæther*, from Greek *pteron*, feather.

FEBRUARY. See CALENDAR.

FELDSPAR, a very common mineral made up mostly of alumina (ALUMINUM oxide), silica (see SILICON), and POTASH, and found chiefly in GRANITE, gneiss, and other igneous ROCKS. It is usually white or flesh color, but sometimes bluish or greenish. Most kinds of CLAY are made from decayed feldspar and those which have most feldspar in them, such as kaolin, are much used in making porcelain (see POTTERY).

The word feldspar is from the German *feldspath*, fieldspar; from *feld*, field, and *spath*, spar.

FELT, a kind of cloth made by the pressing together of the fur and wool of animals. Although hairs and the fibres or threads of wool feel and look smooth and even, they are really notched or jagged all along their sides, the edges of the notches or scales all pointing upward, that is, from the root to the point. This can readily be seen when they are looked at through the MICROSCOPE. When beaten or pressed together, hairs begin to move root first, and keep on moving until they meet others coming from the opposite way, when they twist round each other and lock their jagged edges together. By keeping up the beating all the hairs will finally work together until they form a close mass or mat, which is called felt. Only fur and wool will felt, for neither silk, cotton, flax, nor hemp fibres have the right kind of edges. Curled hairs twine together more closely than straight ones; therefore wool, the fibres of which are curly, makes the best felt. Woollen garments when washed often shrink and become thicker, because the fibres felt together. Felt is used in the manufacture of HATS and in the making of common printed carpets, druggets, table covers, etc.

The word felt is Anglo-Saxon.

FENNEL, a plant cultivated in gardens for its seeds, which are of a spicy and agreeable flavor. The Italians and the Germans use them in cookery, and they are sometimes chewed by country people. Young fennel sprouts make good salad, and the leaves are used for seasoning fish sauces.

The word fennel is from the Anglo-Saxon *fenol*, Latin *feniculum*, fennel.

FERNS. In the United States ferns are only small PLANTS, but in very hot countries they grow into large trees as high as a four-story house and as large round as a man's body. What are commonly called the leaves of ferns are properly fronds. A frond is something between a stem and a leaf; and as it is hard to tell in ferns where the stem ends and the leaf begins, we call them fronds. The frond, which is rolled up in the bud, is often very long when it unfolds, in tree ferns being sometimes more than four times as long as a man. As ferns have no flowers, the seed-holders grow on the under side or on the edges of the fronds, in the form of little capsules or pods, filled with

seeds called spores. When ripe these pods often burst and throw the spores around, and from them new ferns grow. In the common rock fern the spore cups may be seen in two rows of brownish dots on the under side of the frond, one on each side of the rib. In the fern called hart's tongue they are arranged in the same way, but are oblong; in maiden hair a part of the edge of the frond is folded over the pods; and in the brake or bracken the whole edge is folded over them.

There are more than two thousands kinds of ferns in all parts of the world. Most of them grow in warm countries, and many more are found in damp places, such as islands, than on continents. There are many kinds in the West India islands and in the islands of the Pacific. Large tree ferns grow in India, Japan, New Zealand, and the Sandwich Islands. In the South Sea Islands a tree fern called taro used to make the chief food of the people, and it is still much eaten. The roots, the part eaten, are cut into pieces and stacked in the air, where they are left to cure for about a year. When cured they are roasted and then beaten on a stone, when the woody parts come out in threads and leave a very good kind of flour. In Hawaii the whole stem of a tree fern is often baked in the steam which comes up from the cracks of the volcanoes, and eaten with salt. The stems and ribs of some ferns are woven into baskets and hats, and the roots of others are used in medicine; the fronds of several kinds have a very pleasant smell and are used to scent cocoanut oil. The common bracken is said to have great preservative power; it will keep off insects and prevent things from moulding. In England and France fruit is packed in hampers with bracken to keep it from decay, and in the Isle of Man herring for market are packed in its leaves to keep them fresh. In Germany and Denmark mattresses are stuffed with ferns to keep out fleas and bedbugs, and in Scotland cottages are sometimes thatched with bracken.

Many ferns are now cultivated, both in the open air and in hot houses. Many are also raised in glass cases, called Wardian cases, from a Mr. Ward of England, who first found out that ferns would grow in them. They are closed up from the air, aud ferns grow as well in them as in the open air. They make very pretty ornaments for rooms.

In the early ages of the world ferns formed a large part of the plants then growing, and many were very much larger than any now living. A great deal of the hard COAL which we burn was made by the decay of these immense ferns.

The word fern is from the Anglo-Saxon *fearn*, Greek *pteris*, fern, from *pteron*, a wing, a feather.

FERRET, a small animal of the weasel kind, to which belong also the sable, ermine, marten, polecat, mink, skunk, etc. The ferret has a small slim body, usually about a foot long, with very short legs and a tail about five inches long. Its color is generally yellow and black, but many ALBINOS are seen, which has caused people to think that all ferrets are white. It lies hidden in hollow trees, holes in walls, or in burrows during the day, and glides out at night after its prey, which is mostly rabbits, rats, birds, or small reptiles. It seizes its prey just back of the ears, drives its teeth through the spine, and after it is dead sucks its blood. Ferrets are trained to catch rabbits. They are either sent into the burrows muzzled to drive the rabbits out into nets, or are sent in unmuzzled with a string fastened to them to pull them out when they have caught one. They are also used to catch rats and mice, of which they will soon rid a house by following them into their holes.

The ferret is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family.

The word ferret, French *furet*, Low Latin *furetus*, is from the Latin *fur*, thief.

FERTILIZERS. Soil for farming cannot be considered fertile unless it contains everything necessary for the food of plants, in the proper proportion and in the right form. Every crop and every animal raised takes from the soil a part of this plant food. A portion of this used part is replaced from the atmosphere, but another part is forever lost unless it is replaced by man. This makes it necessary to strengthen land with manure, which gives back to the soil the part used up by the growing crop. But the common manure produced on the farm, though good in its way, is not sufficient to keep the land always fertile, because it lacks some of the things sent away every year in the shape of grain, hay, milk, and livestock. It is said that not less than fifty pounds of phosphate of lime are carried off in veal, butter, and cheese for every cow kept in a pasture through a summer. To know how to supply what is lost, the farmer ought to know something about the chemical nature of plants and of soils and of the materials which go to make them (see PLANT FOOD under PLANTS).

Fertilizers are of two kinds, direct, or those which go to make plant food at once, and indirect, or those which act on some matter already in the soil, changing it into plant food. Direct fertilizers are stable manure, refuse vegetable matter, green crops ploughed in, swamp muck, marl, etc. There are also commercial fertilizers which furnish plant food directly, which are made of various natural and chemical substances, ground bones, dried blood, and other refuse matter. Indirect fertilizers are such things as lime, gypsum, salt, etc., which act on soils and make them fit for plants rather than on plants themselves. Commercial fertilizers were first used in England, when the farmers near Sheffield put on their land the bone and ivory clippings from the knife and button factories.

Guano. In 1804 Alexander Von Humboldt called attention to the great deposits of guano on the Chincha islands on the coast of Peru. Guano (Spanish, from Peruvian *huanu*, dung) is composed of the droppings of sea birds, mixed with their decomposed bodies and eggs. Many islands are covered with it to a depth of fifty to one hundred feet, the accumulations of ages. In 1840 some of it was sent in barrels to England and found to be a valuable manure. A great trade soon sprung up in it, and millions of tons were shipped to the United States, Great Britain, and other countries. Other deposits of guano have been found on the coasts of Venezuela, Patagonia, and other parts of South America, and in the islands of the Pacific.

Nitrate. In northern Chili, in the province of Tarapacá, which was taken from Peru in 1880, is a great plain between the Andes and the ocean, 3000 feet above the sea, and stretching north and south about eighty miles. This plain, absolutely dry and free from vegetation, is covered with vast deposits of nitrate of soda, in some places seven to eight feet thick. Its origin is not exactly known, but it is supposed to have come from deposits of guano on the shores of an inland sea, which in the course of ages was changed to its present form. The first cargo of this was sent to England in 1820, and now millions of tons of it are shipped annually. The business, which is largely in the hands of an English company, has made Colonel North, the principal owner, so wealthy, that he is called the "nitrate king."

Phosphate. In South Carolina, not far from Charleston, are great deposits of phosphate of lime, soft enough to be dug out with pick and

shovel. These deposits were known before the Civil War, but were not worked until its close. They are now very valuable and hundreds of thousands of tons are shipped every year to put on land. Immense deposits of phosphate of lime have been found also in Florida.

Kainite is a kind of potash salt formed by the natural evaporation of sea water in past ages, leaving vast deposits near Stassfurt, Germany. Mines had been opened there for salt, on top of which lay enormous beds of matter containing potash and magnesia. This was at first thrown away and dumped on waste land at the mouth of the mine, but in 1860 its value as a fertilizer was found out, and now thousands of tons of it are used in Germany, and it is shipped to many parts of the world, even to Brazil and Ceylon for use on the coffee plantations.

Apatite is a kind of mineral phosphate, mined in large quantities in Canada, and shipped mostly to England where it is valued as a fertilizer.

Many other kinds of commercial fertilizers are made of bones, fish scraps, cotton seed refuse, slaughter house refuse, etc. Fish scraps, the refuse of the fish oil factories (see MENHADEN), when dried and pulverized is called fish guano.

FIFE, a small musical wind instrument, used with the drum for playing military music. It is a short tube closed at one end, with holes in it. The player blows into the hole nearest the closed end, and makes the tune by closing and opening the other holes with his fingers. The music is very shrill. The fife is a very ancient instrument, having been used by the Greeks.

The word fife is in French *fifre*, in German *pfeife*, and in Italian *piffaro*, and is perhaps related to the Latin *pipa*, a pipe.

FIG, the fruit of the tree which grows wild from the east of Persia through the countries about the Mediterranean. The tree is sometimes three times as high as a man, but is generally only a shrub. It bears several crops of fruit each year. There are nearly fifty kinds of figs, some of which are yellow when ripe, and others white, green, brown, or black. Fresh figs are very sweet and delicious, but many do not like them at first; after a time, however, they prefer them to dried figs. The figs used in the United States come mostly from Smyrna, where they are dried and pressed into boxes. In some of the Southern States and in California figs will ripen in the open air, but in the Middle and Northern States they are generally raised in hot-houses.

The word fig is from the Anglo-Saxon *fic*, which is from the Latin *ficus*, fig.

FILBERT. See HAZEL.

FILE, a steel tool with sharp teeth, used for cutting down or smoothing the surfaces of metals, wood, etc. A rasp is a kind of file, but it has coarse single teeth, made by blows of a punch, instead of long teeth cut across by blows of a chisel, Files are made of many different shapes, flat, square, triangular or three-sided, round, etc., and vary from about one inch to nearly a yard long. They are made of the best steel, but they are of different degrees of hardness, according to the kind of work they are made for.

In making a file, a piece of bar steel is heated red-hot and is then forged, or hammered into shape, on an ANVIL. The blank, as it is now called, is then heated in an oven and allowed to cool slowly, which softens the steel by taking the CARBON out of it. It is next ground down smooth on a grindstone, or filed down if it is a small file blank. The blanks thus prepared are then taken to the file-cutter, who sits astride of a bench in front of a stone anvil. He lays a blank on the anvil, holding it tightly in place by means of a leather strap which passes under

his feet, and then cuts the teeth in it one by one with a chisel held in his left hand, striking it with a hammer held in his right hand. Each tooth is made singly with one blow, which is struck slanting, so that a burr, or ridge of metal, is raised only on one side of the cut. The cuts are made with the greatest regularity, all being exactly the same distance apart and of the same depth. Most files are double cut, that is, they have two rows of cuts with cross each other. The second row is cut in the same way with the first, but the cuts are closer together and not quite so deep. There are many machines for cutting files, which do very fine work, but it is said that hand made files are the best.

The files are then hardened by heating them and cooling them suddenly in water, after which they are scoured in sand, washed with limewater, dried, and rubbed with olive toil and turpentine; and after each one has been tested they are put up in packages for market.

The word file is from the Anglo-Saxon *feol*, file.

FILIGREE, a delicate kind of work made of fine gold or silver wire. The wire is mostly made flat instead of round, and is twisted into spirals and other forms, which are afterward joined together into a kind of metallic lace-work, and made into ornaments of various kinds. Filigree work is made mostly in India, Turkey, and Italy. It is sometimes called Maltese work, because much of it is made in Malta. The natives of Sumatra are also skilful filigree workers, both in gold and silver, and the Chinese make silver filigree, but of an inferior kind.

The word filigree is from the Italian *filigrana*, filigree, from *filo*, Latin *filum*, a thread or wire, and *grano*, Latin *granum*, a grain or bead, the old filigree work being often ornamented with beads.

FILTER, anything which strains dirt and settlings out of liquids. Common rain water is usually yellowish on account of the fine dust, smoke, and other impurities which it gathers in falling through the air. But after it has been strained through the earth and has run into springs and wells, it is clear and bright. This is because the beds of sand and gravel through which it trickles are natural filters which take out all impurities and colors. Filters, used in houses to make water clear, work in just the same way. In former times sand and gravel was mostly used in them; but as they

Common Filter.

will not take gases (see ELEMENT) out of water, charcoal is now generally used with it. CHARCOAL is the best of all things for filtering. The dirtiest water poured through it comes out sweet, clear, and bright. Animal charcoal, made from burnt BONES, is better than wood charcoal for this, because it will take up much more gas and will destroy all animal matter in water.

Filters are very necessary where water is not perfectly pure, because such water is apt to cause sickness. Indeed, a great part of the sick-

ness in cities and villages is caused by drinking impure water. Water which is roiled or which has any unpleasant smell or taste about it should never be drunk until it has been filtered.

There are many kinds of filters, but most of them work in nearly the same way. One of the simplest kind is shown in the picture. In this *a* is a wooden box, open on one side, with a shelf *m*, near the bottom, leaving room enough under it for the pitcher, *b*. On the shelf is put a common stone jar, *c c*, which has a hole in the bottom fitted with a faucet which comes through the hole, *e*, in the shelf. A large sponge, *f*, is first put over the hole in the jar, and over this a piece of thin muslin, *g*. Next some clean, white sand, *h*, is put in, then some charcoal, *i*, pounded fine, and lastly some small pebbles, *j*. In the top of the jar is set a common flower-pot, *d*, with a sponge, *k*, in the hole in its bottom. Such a filter is made to sit under a hydrant, so that water can run through it all the time; but it may also be put where water can be pumped into it, or it may be filled by a bucket. When the flower-pot is kept filled with water, the water, *l*, runs through the sponge, *k*, and then through the other layers until it comes through the faucet, *e*, into the pitcher. It will then be clear and sweet, even if muddy when it went in at the top.

The word filter ought to be spelled felter, as it is made from FELT, which was formerly much used to strain liquids through.

FIR, a cone-bearing tree, belonging to the same family with the spruce and the hemlock. The firs grow mostly in cold countries, though some are found in Mexico. The balsam fir is common in the Northern United States and in Canada. Its wood is not worth much for timber, but it has a valuable juice, which comes out through its bark and looks like honey, called Canada balsam, or balm of Gilead. When mixed with spirits of turpentine this makes a good varnish for maps, and it is also used for mounting objects for the MICROSCOPE. On the Pacific coast of America is found the noble silver fir which grows two hundred feet high, or as high as an ordinary church steeple.

The word fir is from the Anglo-Saxon *furh*.

FIRE. Burning, as is told in the article OXYGEN, is only the union of oxygen with something else. When this union takes place slowly, heat is made, but we see no fire or light; when it takes place quickly, both heat is felt and fire or flame is seen. When iron rusts, it is the same kind of burning as when wood blazes in the fire; but the oxygen of the air unites with the iron so slowly that the heat is not enough to be felt. If the union be made to take place quickly, both heat will be felt and light will be seen. When the heel of your boot strikes a stone, you often see a spark fly from it. This is burning iron. The iron nail in your heel strikes the stone, a bit of it is knocked off, and heat enough is made by the blow to cause the iron to unite with the oxygen of the air, and thus we see it burn. A piece of iron or steel may easily be heated enough to make it burn in a jar of oxygen, and a most brilliant light will be given off by it. When wood or coal is set on fire, it gives out both heat and light; but if we could give it still more oxygen it would burn still brighter. We do this when we blow a fire with the bellows, and this is the reason why it then blazes up and burns more briskly. Some things take fire, that is, unite with oxygen, much more easily than others. When we scratch a match it at once bursts into a flame. This is because it has a little PHOSPHORUS on the end, and this has such a liking for oxygen that it has usually to be kept in water to keep it from uniting with

it. The phosphorus on the end of the match is mixed with glue, which keeps it from taking fire; but when the match is scratched on any rough thing heat enough is made to cause the phosphorus to unite quickly with the oxygen of the air, and it bursts into flame. Wood and coal have not so great a liking for oxygen as phosphorus, and need much more heat to make them unite with oxygen.

A burning candle is a small fire, and by studying it we can easily find out much about fire and flame. The wick and the tallow will not unite with oxygen at the common heat of the air, but need to be raised to a higher heat. If we hold a lighted match to the wick, it will soon be heated enough, and will unite with the oxygen around it and burst into flame. The burning wick gives some of its heat to the tallow, which melts and is sucked up by the wick and becomes warm enough to burn also. Thus the tallow is heated little by little, and both it and the wick burn up, and, so far as we can see, are lost. But are they really lost? No, the CARBON, of which the wick and the tallow are mostly made up, has united with the oxygen of the air, and formed CARBONIC ACID, and this has passed off as a gas into the air and mixed with it. Not a bit of the carbon has been lost; it has only united with the oxygen of the air to form another substance. The tallow and the wick have in them some HYDROGEN as well as carbon, and when the candle burns this also unites with the oxygen of the air, and this union forms WATER. If you hold a cool, dry tumbler over the flame of a burning candle, the inside of the glass will become dimmed at once, and little drops of water will collect on it. If we could keep the glass always cool we could easily get a cup of water in this way by burning candles. This water passes off from the flame as a hot STEAM, which cannot be seen; and when we hold the cool glass over the candle it is cooled and turned into water.

We thus see that the tallow and the wick have not been destroyed, but have been changed into carbonic acid and water, and this change has produced heat and light. It is the same when a wood or a coal fire burns; the hydrogen and the carbon in them turn into steam and carbonic acid gas, and fly away up the chimney and mix with the air.

I have said that the melted tallow of the candle burns, but it is really turned into a gas by the heat, and it is the gas which burns or unites with the oxygen of the air. This gas is hydrogen gas filled with particles of carbon, and is much the same as common coal gas. Indeed, a candle is a small gas works, in which gas is distilled (see ALCOHOL) from tallow, or whatever the candle is made of, just as common GAS is distilled from coal. The flame of a candle is made up of three parts, as shown in the picture, Fig. 1. In the inside of it is a space (1) filled with gas which is not burning. You can prove this by putting one end of a glass tube into the black centre of the flame; the unburnt gas will pass through the tube and may be lighted at the other end. The part next to this inside space, marked 2 in the picture, is the one which gives off the most light. Some of the oxygen from the outer air gets into this, but not enough to oxidize or burn both the hydrogen and the carbon, and as it likes the hydrogen best it unites with that and burns it. Hydrogen makes a very hot flame, but

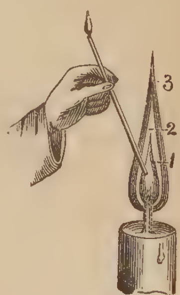


Fig. 1.—Flame of Candle.

does not give much light. In burning, however, it heats the floating particles of carbon white-hot, and this is what makes the light. In the outer part of the flame (3) the oxygen unites freely with the carbon, and makes carbonic acid, which passes off into the air. This burning of the carbon makes much heat, but very little light. Thus the light of a candle, lamp, or gas flame is due to the fact that the hydrogen and carbon that make up its gas do not burn at the same time; the hydrogen burns first, and this heats the particles of carbon to a white heat, and these particles give the light. If you look closely at a gas jet you will see it sparkle brightly. These little sparks are the particles of carbon heated white-hot by the hydrogen, and which do not burn up until they get to the outside of the flame. When there is not enough oxygen to burn up all the carbon, the carbon passes off in little particles as soot, and we say that the candle or the fire smokes.

Some travellers have told stories about races of men in the world who had never seen fire nor heard of it, but these tales are very doubtful, and it is probable that even the most savage races have known its use. The old Hindoos and Greeks thought that fire was stolen and brought down from heaven by man; but some ancient peoples thought that fire was an animal. Herodotus the historian says that the Egyptians believed it to be a living beast, which ate everything it could seize, and when filled with food died of it. The Australians have a singular story about the way in which they first got fire. They say that a long time ago a little bandicoot (a sharp-nosed Australian animal, somewhat like a Guinea pig) was the sole owner of a firebrand and so selfish was he that he refused to share it with the other animals. So the animals held a council and decided to get the fire away from the bandicoot, and they appointed the hawk and the pigeon to do it. They tried to persuade him at first to share the blessing with his neighbors, but he refused, and the pigeon made a dash to seize it. The bandicoot threw the fire brand toward the river, hoping to put it out, but the sharp-

Fig. 2.—Making Fire by Rubbing Wood.

eyed hawk, seeing it falling, knocked it with a stroke of his wing far over the river into the long, dry grass. The grass caught fire, the flames

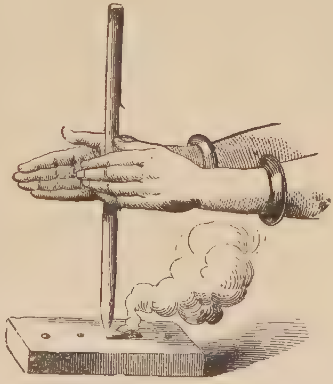


Fig. 3.—Fire-Drill.

spread over the country, and the people felt the heat and found it good.

We, who can make fire by simply striking a match, would think it very hard if we had to rub together two pieces of wood until they grew so

hot as to blaze before we could make a fire. But it is probable that this was one of the first ways of making a fire. The Sandwich Islanders, and the people of Tahiti, New Zealand, and other islands of the Pacific Ocean, used to kindle fires by rubbing a pointed stick rapidly up and down

Fig. 4.—Esquimau Fire-Drill.

upon a piece of soft dry wood, as shown in Fig. 2. They could make fire in this way in a few seconds. Another instrument for fire making, called the fire-drill, is shown in Fig. 3.

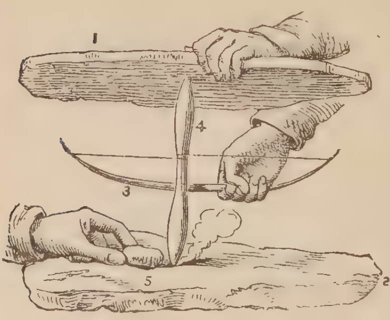


Fig. 5.—Bow Fire-Drill.

This was used by the ancient Mexicans, and in Australia, China, South Africa, and other places. The Esquimaux have a different way of turning the fire-drill, which can be seen in Fig. 4. One man holds a cross-piece which has a hollow on the under side for the top of the drill to fit into, and presses down hard on it, while the other man turns it by pulling first one end and then the other of a cord twisted round it. The Sioux, Dacotahs, and some other of the North American Indians, turned the drill in still another way, by means of a bow, with a loose string, which is wound once around the drill, as shown in the picture (Fig. 5). In this, 1 is a stone, held by a man's left hand, with a hollow in it to hold the upper end of the drill, and 2 is a piece of wood in which the lower point turns; 3 is the bow, held by the right hand, and 4 the drill, and 5 is a piece of punk or some other light and dry thing which another man is holding to catch the fire. The Iroquois Indians used a kind of pump-drill, like the one shown in Fig. 3 in the article DRILL.

Many other ways of getting fire have been used by other people. The Greeks and Romans struck sparks from flints with a piece of hard iron or steel, but they knew also the use of the burning-glass or LENS. Some of the North American Indians, and the Indians of Terra del Fuego, also know how to strike fire with flints, and the Chinese use both flint and steel and the burning-glass. In China, too, fire is sometimes made by striking together two pieces of BAMBOO, the bamboo having silica (see SILICON) enough in its outer skin to make it strike fire.

The word fire comes from the Anglo-Saxon *fyr*, which is from the Greek *pur*, fire.

FIREFLY, the common name of several kinds of BEETLES, which give out light when flying. They are sometimes called also fire beetles and lightning-bugs. There are two classes of them, one of which is found in Central and South America and the West Indies, and the other in Europe and the United States. One kind is called the lightning spring beetle, because when it falls on its back it springs into the air so as to get on its feet again. It is more than an inch long, and gives forth such a beautiful bright light that the Cuban and Mexican ladies use it as an ornament.

The Indians catch them by holding up burning coals on the end of a stick, which draws the insects to them. They sell them to ladies, who shut them up in small cages of fine wire, and feed them on bits of sugar cane. They have also to bathe them frequently to keep them alive. When they wish to use them, they sew them up in little bags of lace or gauze, which they pin on their skirts, or twist them up in lace necklaces or girdles. Sometimes they put a long pin through them, under the chest, which does not hurt them, and stick them in their hair, with humming birds and real diamonds, thus making a very beautiful headdress. The Indians use these fireflies to light their dwellings, several of them together giving out light enough to read by.

The fireflies which abound on summer evenings in the United States are smaller than the lightning spring beetles, and give much less light. The glow-worms of Europe belong to the same class with them. Only the male can fly, the female, which gives out a much brighter light, being wingless. The light of fireflies is given out from the lower parts of the abdomen, but we do not yet know exactly what causes it.

Glowworms.
Female. Male.

Fireflies belong to the order *coleoptera*, or sheath-winged INSECTS.

The word firefly is made up of FIRE and FLY.

FIREWORKS. There are so many kinds of fireworks and so many things are used in making them that only a few of them can be told about in this short article. Among the most common kinds are fire-crackers, torpedoes, sky-rockets, Roman candles, Catharine wheels, and Bengal lights. Fire-crackers are only a little gunpowder rolled up in very tough paper, with a twisted roll of match paper sticking out of one end to light them by. They are brought from China, where they can be made much cheaper than in any other country, because labor is so cheap. The wholesale price in China of a pack of fire-crackers, which are sold here at eight cents, is only two cents. As there are eighty in each pack, a Chinaman therefore makes forty crackers for less than a cent. Most fire-crackers are made by poor people in their spare time, just as toys are made by peasants in Germany. Merchants in Hong Kong buy them, pack them in boxes holding forty packs each, and ship them

to foreign countries. Those which are brought to the United States come mostly in sailing vessels around Cape Horn. They are so cheap that the merchants could not afford to pay much for bringing them, so they are used as ballast in ships which carry silks and teas. The Chinese letters printed on the wrappers of fire-cracker packs are only the advertisements of the dealers, telling where they can be bought in China. Fire-crackers are used almost all over the world. In the Northern United States they are fired mostly on the Fourth of July, but in the Southern States Christmas is the great time for them. In China they are fired chiefly on New Year's Day, but in Canton and some other cities they are fired at almost all hours of the day and night, because the people think the noise will frighten away evil spirits. In England they are used mostly on the fifth of November, or Guy Fawkes' Day, and in South America on all church and other festivals.

Torpedoes or throwing crackers are made by wrapping up a little fulminating powder, or powder which goes off with a noise when struck or rubbed hard, in pieces of thin paper, with some very small gravel stones or a little sand. When the torpedo is thrown against any hard object the gravel rubs the powder and it goes off. Torpedoes used here are all made in this country, mostly by German families around New York city.

Fireworks meant to make a show rather that a noise, such as rockets and Roman candles, are made up mostly of gunpowder, and of the things from which gunpowder is made, saltpetre, sulphur, and charcoal. When iron or steel filings are mixed in, fireworks burn much more brightly and throw out beautiful sparks, often seen when rockets burst in the air. Copper filings make green fire, and zinc filings bright blue fire. Yellow fire is made by resin, amber, and common-salt, red by lampblack and the salt of strontium, and pink by much saltpetre.

The cases for fireworks are made by rolling pasted common brown paper tightly round a wooden roller, and cutting it up when dry into tubes of the right lengths for the kind wanted. One end is closed up, and the powder and other things are poured in and rammed down with a wooden ramrod. In filling rockets, a hollow space is left, as shown in the picture, else the rocket would not rise. The match by which it is to be fired is then put in, and the other end is also closed with paper. When the tubes are all filled, girls finish them by pasting around them gilt, silvered, and fancy-colored papers.


Rocket.

A pointed cap of paste board is usually put on the top of rockets, so that they will cut through the air easier, and a long stick is fastened to the side to act as a balance when they go up. If a rocket were sent up without any stick, it would fly all round like a serpent or squib. When rockets reach the end of their flight, they often send out clusters of stars of different colors, swarms of fiery serpents, or showers of gold, silver, or colored rain. All of these come out of the top part of the rocket, where, joined on to the tube, is a shorter and broader part filled with various kinds of powder made into a paste with alcohol, and cut into stars or made into round drops for rain. The different colors are made of various mixtures, some of which are told about above. Serpents are made by packing many little squibs into the top of the tube so that they will all take fire at once.

Roman candles are made by packing a little of the same mixture which

is put into rockets, into the bottom of the case, then a little gunpowder on top of that, then a ball or a star on top of the gunpowder, and so on, putting in one kind after the other in the same order until the tube is filled. The balls or stars, which are often of several beautiful colors, are made up of various things, such as sulphur, saltpetre, quartz, antimony, gunpowder, etc., mixed together with alcohol or gum-water into a paste, then made into the shape wanted, and dried. When the tube is filled the end is closed by pasting a piece of match paper round it and twisting into a roll. When this is fired the Roman candle throws out a shower of sparks for a little while. and as it burns down the gunpowder fires the balls into the air one after the other.

Catharine wheels are so called from St. Catharine of Alexandria, who was put to death (307 A. D.) after being tortured on a wheel. They are made of a great many sizes, the smallest being usually called pin-wheels, because they can be fastened up with a pin. They are made by filling a long tube of paper with powder much like that used in rockets, and then winding it in a coil round a thin wheel of wood. The end of the tube on the outside of the wheel is covered with a piece of match paper, which is twisted into a roll or fuse to light it by. When a Catharine wheel is fastened up on a post or board so that it will turn round easily, and the fuse is lighted, the powder in it acts just like the powder in the rocket, only it pushes the tube round and round instead of straight upward, and thus the wheel is made to turn with great rapidity. Some wheels are made in different parts, and each part of a different color, so that it changes as it turns.

Bengal lights are short tubes filled with a mixture of SALTPETRE, SULPHUR, and ANTIMONY. They burn with a great glare of bluish-white light, and are much used as signals, especially by ships at sea.

Besides the small fireworks used mostly by children, there are many large kinds which the manufacturers call exhibition pieces, because they are intended to exhibit on the Fourth of July and other great days. These pieces, some of which are very costly, show when fired such designs as flags, shields, eagles, etc. They are bought chiefly by cities and are set off in parks or large squares where the most people can see them.

Great numbers of fireworks of all kinds are made in factories in New Jersey, on Long Island, and in other places around New York. Fireworks were first made by the Chinese, who invented GUNPOWDER, early in the seventh century A. D.; and a great many are still made by them, but those made here are much handsomer than any brought from China.

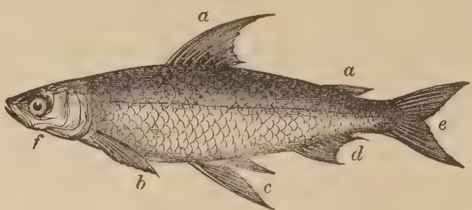
The word firework is made up of FIRE and work, Anglo-Saxon *weorc*.

FISHES. This class of ANIMALS, like other vertebrates, have an inside skeleton, with a spinal marrow running through a backbone, but unlike others they are fitted to live all the time in the water. This they are able to do because they can breathe the air which is mixed with water. They have no lungs, like animals that breathe common air, but have on each side of the head openings called gills. These gills have a hard outside cover or lid, while the inside is made up of a series of fringes formed of many little veins filled with blood. Fishes take water into the mouth and pass it out again through the gills, and the air in the water is taken up by the blood vessels in the fringes and thus passes into the other veins and all through the body. The heart of fishes is single and not double like that of MAMMALS and BIRDS. Their blood is cold, like that of REPTILES, and therefore they do not feel changes in the heat or cold of the water. This fits them to live in the cold waters of the north

as well as in warmer seas, and many kinds, such as the cod and the herring, are found far up in the Arctic regions.

Fishes are nearly of the same weight as the water in which they live, so that they can move in it with great ease. Most of them have also an air bladder inside the body, which enables them to go up or down in the water at will. When a fish wishes to go down deep it can press the air out of this bladder by means of certain MUSCLES, and so increase the weight of its body; and when it wishes to rise again it takes off the pressure, the bladder fills with air again, and its body becomes light enough to rise. The form, smooth surface, and fins and tails of fishes are especially fitted for rapid movement in the water. Their bodies are mostly regular in shape and smooth, with no angles to catch the water in swimming. Instead of having feathers or fur, which would only hinder them, and which they do not need to keep them warm because they are cold-blooded, they have a smooth covering of scales, which overlap each other like shingles, and are covered with a kind of slime, which helps them to slip through the water.

Fishes are noted for their beautiful colors, which range from gold, silver, and copper tints to the loveliest blue, green, red, and black. The mackerel shows all the colors of the rainbow, and the red mullet has been celebrated from ancient times for its beauty. Among the Romans the rich used to have a live mullet put on a platter at dinner so that the guests might watch the changing of its colors, through all the shades of purple, violet, and blue, to red and white, as it slowly died. In Japan is caught a fish called the angel fish, which is of a most beautiful sky blue color, marked sometimes with rainbow tints.



Fish, showing the different Fins.

a a, Dorsal fins; *b*, Pectoral fin of one side; *c*, Ventral fins; *d*, Anal fin; *e*, Caudal or tail fin; *f*, Cover of gill.

Fishes swim chiefly with the tail, which acts like an oar in sculling. Like the fins, it is made of a skin stretched over a bony framework. Most fishes have four kinds of fins, which may be seen in the picture; one or more on the back, *a a*, called dorsal fins (Latin *dorsualis* from *dorsum*, the back); a pair of side fins, *b*, called pectoral (Latin *pectoralis*, from *pectus*, the breast), because they are on the sides of the breast, near the gills; a pair beneath, *c*, called ventral fins (Latin *ventralis*, from *venter*, the belly), because they are usually in the middle of the belly; and one or more anal fins, *d* (from Latin *anus*, the opening of the food canal), between the belly and the tail. The pectoral fins answer to the fore legs, and the ventral fins to the hind legs of land animals. Their use is to keep the fish in an upright position in the water, and they also aid it in directing its course. The other fins, the dorsal and anal, help the tail or caudal fin, *e* (Latin *cauda*,

a tail), in pushing the fish forward. In the flying fish the pectoral fins are so large, as is shown in the picture, that they are almost equal to wings. With their aid the fish can spring out of the water and fly through the air several hundred feet before it drops back again. Most fishes can swim very fast. The salmon can go 20 to 25 miles in an hour, or as fast as the fastest steamboat.

Fishes generally have all the senses, but those of taste and of touch are very dull. They can hear, although they have no outside ear. Their eyes are usually very large and immovable, and their sight is sharp, but a few, living in the mud or in the waters of caverns, have no eyes at all. Fishes mouths differ much from each other; some have no teeth, some have sharp teeth for cutting, and some blunt teeth for crushing. They live mostly on animal food, such as worms, snails, crabs, lobsters, etc., and many of the large fish on little fish. Some swallow their food alive, and some tear it up before swallowing.

Most fishes are oviparous (Latin *oviparus*, from *ovum*, egg, and *parere*, to bring forth), that is, their young are hatched from EGGS laid by the parent. The eggs, which are called spawn, are laid in different places according to the nature of the

Flying Fish.

fish. Some fishes lay them on the leaves of water plants or sea-weed, some on beds of sand or gravel in shallow water along the coast, and some that live in the ocean lay them near the head waters of rivers, up which they go every year for this purpose. Very few fishes take any care of their young, but leave their eggs to be hatched out by the sun. The most valuable fishes lay a great many eggs, while others lay but few; thus, the herring lays many thousands and the cod several millions every year, but the shark only two. The sea would be filled full of fish if all the eggs that are laid were hatched and raised, but many of the eggs are destroyed and great numbers of young fish are devoured by birds, reptiles, and other fish.

Fishes are vastly more numerous than all the other vertebrates put together. Some are fitted to live in salt water only, some in fresh water only, while others live in both. Some live in one place, and some wander from place to place in great bodies called schools. Those which inhabit shallow waters are of the brightest colors, due mostly to the light, while those which live in deep water where much light does not reach, are generally dull in color.

Most of the common fishes are told about under their own names, but there are a great many very singular fishes in the sea which we have

not room to describe. For instance, in Central America is a fish called the dora or hassar, which leaves its pond when the water dries up and marches overland in large droves in search of more water, moving along by little leaps; and in Malabar is a small fish called the sennal, which climbs up the trunks of palm trees growing near the water's edge. The archer-fish of Japan lives on insects which it shoots with a drop of water blown from its long snout. Another fish, called the angler, has several spines like little fish-poles rising from its head, and on the end of each hangs a lump which looks like flesh. The angler lies hidden with its baits hung out, and when small fish come to nibble, it catches them. The remora or sucking-fish has a flat sucker on its head, by which it can fasten itself to anything; and it is said to often hang on to a larger fish so as to be carried around by it wherever it goes. The ancients believed that this fish could stop a ship, and Pliny says that at the battle of Actium the ship of Antony was held so tightly by a remora that it could not move, and this was why Augustus won the battle. These fishes are used in catching TURTLES. Though most fishes are mute, there are some which make noises like a groan or cry. Tunnies cry like children when they are taken from the water, and in the waters of South America is a little white fish, with blue spots on its back, which sings all night long, the tones sounding like a far-off organ.

The Chinese have raised fish by hand from the most ancient times, and the Romans bred fish to supply their tables. In France, England, and other European countries, and in several parts of the United States, fish-breeding is carried on with much success. Among the kinds of fish raised in this country are salmon, including trout and shad. The spawn or eggs of the fish, which are pressed out with the fingers, are put into hatching troughs, or long narrow boxes divided into parts by slats on the bottom. Cold spring water, filtered through flannel, comes in at the head of the trough, passes over the eggs, and flows out of the lower end. In about two months the eggs burst open and the water in the troughs becomes filled with millions of little wrigglings things, which look like fish with eggs hung to them. These are little sacs from which they get their food at first, but in a short time they become strong enough to take care of themselves, and they are then turned loose into the stream, from which they find their way at last into the sea. In this way many of our streams and rivers from which the fish had mostly disappeared, have been filled again with salmon, trout, and shad.

Fishes form the fifth class of vertebrate ANIMALS.

The word fish is from the Anglo-Saxon *fisc*, Latin *piscis*, fish.

FISH HAWK. The American fish-hawk, or osprey, as it is sometimes called, is found almost all over the United States, living in the northern parts in the summer and in the southern parts in the winter. It looks much like the eagle, and is quite a large bird, some of them measuring five to six feet, or nearly the length of a man, across the wings. It lives near lakes, and bays, but is sometimes seen several hundred miles at sea. It never follows game in the air, as it lives on fish. When, in flying along above the water, it sees a fish, it closes its wings, and swoops down headlong on it, often going entirely under water. A fish-hawk can carry off a fish weighing five pounds, but it has been known to strike a fish too heavy for it to lift, and to be drawn under and drowned; and the next tide sweeps it upon the beach with its claws buried deep in its prey.

The fish-hawk has many battles with the bald EAGLE, a hungry, thievish bird, which seldom works when it can steal. The eagle watches

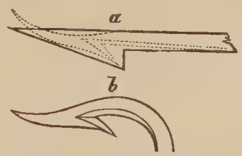
until the fish-hawk has caught a fish and then pounces upon it. The two rise into the air, fighting with beaks and claws, but though the fish-hawk is brave, the eagle is the stronger and generally gets away the fish and carries it off to eat. The fish-hawk never tries to get back its fish, but goes to work to catch another one.

Fish-hawks build large pouch-shaped nests not far from the water, in the forks of the pine, oak, and other strong trees. They are made of sticks, corn stalks, mullein stalks, and such things, piled up in a solid mass and lined with soft seaweed. They are not very deep, but are nearly flat on top and are built strong enough to last, for the fish-hawk comes back to the same nest year after year. It lays three or four eggs, a little larger than hens' eggs, yellowish-white spotted with reddish-brown. The eggs are hatched about the end of June. The female seldom leaves the nest, but the male goes fishing and supplies the family with food. The young ones are very awkward and are slow in learning to fly. It is said that their parents sometimes have to peck them and beat them out with their wings before they will leave the nest.

Fishermen say that the fish-hawks come back in the spring with the fish, and they therefore welcome them and begin to repair their nets and get their hooks and lines ready when they appear. They also like to have them build their nests near where they live, for they think they bring good luck.

The fish-hawk belongs to the order *raptores*, or BIRDS of prey, and to the falcon family, which includes also other HAWKS, the FALCONS, and the EAGLES.

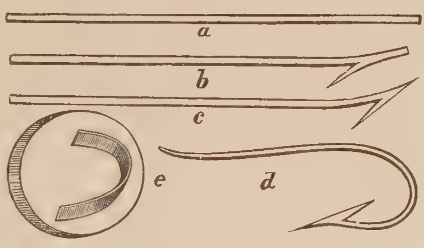
FISH-HOOK. The best fish-hooks are those called Limerick hooks, because first made in Limerick, Ireland. They are hammered square out of the best of iron, usually from the nails of old horse shoes, and afterward filed round, the barb being filed out of a solid piece, as shown in the picture; *a* being the



Barb of Limerick Hook.

barb hammered out rough, and *b* the barb finished. When finished they are hardened by being heated in a charcoal fire and then cooled suddenly by being put into cold water. Limerick hooks are not flattened at the end, as common fish-hooks are, but have some little dents filed in the shank to give a hold to the thread by which it is fastened on to the line.

Common fish-hooks are not hammered out, but are made from round iron wire. The wire is first cut into the right lengths for hooks, as shown in *a*, in the second picture.



Fish-Hook Making.

The pieces are then softened by heating them in a furnace, and the workman sets them up, three at a time, in a little stand on his work-bench, and with a sharp knife cuts up a slice of the metal near the end

of each, as shown in *b*. This makes the barb or beard of the hook. The point is next filed sharp, as in *c*, and the hook is then bent round the outside of a piece of brass fastened on a small *block* of wood, shown in *e*. This gives it the shape *d*, and the end is then flattened down by hammering it on an anvil. The hooks are lastly hardened, and after being smoothed by turning them around quickly in a barrel with EMERY powder and soap, are blued by heating them in hot sand.

Fish-hooks are still made in this way by hand in England, but in the United States they are now made mostly by machines, which do their work very fast.

The word fish-hook is made up of FISH, and hook, Anglo-Saxon *hōc*, a hook.

FLAG, a piece of light cloth, generally of several colors, used by a nation as a banner or ensign. In common language, the words banner, ensign, standard, colors, and flag mean nearly the same thing. Some nations, however, have two or more flags, each of which has a special use. For example, Great Britain has a flag called the royal standard, which is hoisted only when the sovereign is present, or on great occasions like royal birthdays; a naval ensign, used on ships of war; and a flag, used by the army and on merchant ships. In old times flags were of all sorts of shapes, square, triangular, and long and pointed, some with only two points and some with many; but now almost all flags are oblong, or a little longer than they are wide. There are some exceptions, as will be seen in the picture at the beginning of this book, the naval flags of Denmark and of Sweden being pointed, and the flag of China being shaped like a triangle. In old times, too, flags were often of only one color, but now all national flags are either made up of several colors or have something on them, such as a cross, a shield, an eagle, or stars, to mark them so that they can be told from other flags. Flags of only one color are now used by almost all nations to mean something: for example, a white flag means peace, and is used for a flag of truce; a red flag means defiance and is used by revolutionists, but is sometimes used to mean danger, and is hoisted on men-of-war when powder is being taken on board; a black flag means death, and is used by pirates, and sometimes by soldiers, to show that no quarter will be given; and a yellow flag means sickness, and is hoisted over hospitals and quarantine stations.

The flag of the United States of America is made up of thirteen stripes, seven red and six white, so that a red stripe comes at both the top and bottom, and a blue union, sprinkled with as many stars as there are States in the Union, in the upper corner next to the staff. The law does not tell how the stars, of which there are now forty-four, shall be placed, so that in making a flag they may be arranged just as one pleases; but in the flag used by the army they are generally made into one large star; while in those used by the navy they are placed in straight lines. The blue union, when used separately as a flag, is called the union jack. The revenue flag of the United States is made up of sixteen stripes, eight red and eight white, running up and down, and a white union in the corner with the national arms in blue on it. The yacht flag used by all yacht clubs in the United States is just like the national flag, only the union has in it, instead of a star for each State, a foul anchor in a circle of thirteen stars.

The national flags of all the other principal nations are shown in the picture, but some will need to be explained. The large red cross in the naval flag of Great Britain is called the cross of St. George. The same cross

but smaller, is seen in the union in the corner of the flag, where it is shown with a white edge, because the cross of St. George is properly a red cross on a white ground. The other cross on the union, running diagonally, or from corner to corner, is made up of two crosses, the cross of St. Andrew (for Scotland), which is white on a blue ground, and the cross of St. Patrick (for Ireland), which is red on a white ground; so that the two being put together, the cross looks like a double red cross with white edges. The royal standard of Great Britain is made up of four parts, red, yellow, blue, and red, with the arms of England, Ireland, and Scotland on them. France, being now a republic, has no royal standard. The German naval flag is the same as the imperial standard. The black eagle in the middle is the eagle of the German empire and the small black cross on a black, white, and red ground in the corner is the cross of Prussia. The imperial standard of Russia is yellow, with the double-headed eagle on it. This eagle was first used by the Emperor Constantine the Great, the two heads meaning the Eastern and Western Roman Empires. The Austrian imperial standard is also yellow, with the double-headed eagle on it, but it has a border of different colors around it. The royal standard of Italy is the same as the national flag, shown in the picture. The arms on it are those of Savoy. The royal standard of Spain is like the naval flag. That of Portugal is red, with the royal arms on it. The royal standards of the Netherlands and of Belgium are the same as the merchant flags, shown in the picture, but each has the royal arms on the middle bar or stripe. The merchant flag of Denmark is like the naval flag, but oblong instead of pointed. The merchant flag of Sweden is also like the naval flag, but without the points, and the merchant flag of Greece is the same as the naval flag, only the crown is left out. Most of the other countries have only one flag.

The word flag comes from the verb flag, meaning to droop, to hang down loosely.

FLAMINGO, a bird which gets its name from its red or flaming color. It has a large head, with a bill bent in the middle, a very long neck, a rather small body, and long legs with feet webbed like those of a duck. Flamingoes live in the warm parts of the globe, especially along the seashore and in marshes, where they feed on MOLLUSKS, CRUSTACEANS, and small fish. One acts as sentinel while the rest feed, and on the coming of danger gives a trumpetlike call and starts off, the rest following, sometimes in Indian file and sometimes in triangular lines as wild geese fly.

The **American Flamingo,** found in the West Indies and in Florida and Alabama, is about four feet long from bill to end of tail, and five and a quarter feet to end of claws. It builds a nest on a hillock of mud about two feet high, lays two or three white eggs as large as goose eggs, and covers them standing. The young, which take to the water as soon as hatched, are rose-color the first year, and become scarlet the second year. The flamingo may easily be tamed. The flesh, which is excellent, was highly esteemed by the Romans.

Some put the flamingo among the *natatores* or swimmers, and some among the *grallatores* or waders.

FLAX, fibres or threads from the stem of the flax plant, from which LINEN thread and cloth are made. Flax grows wild in all the countries around the Mediterranean. It was cultivated four or five thousand years ago in Mesopotamia, Assyria, and Egypt. There are now many kinds of the flax plant in different parts of the world. The common kind has a straight slender stem, two or three

feet high, branching near the top, and bearing beautiful blue flowers. These are followed by seed vessels, containing slippery brown seed, the LINSEED of commerce. The stalks are hollow pipes made up of a woody part called the boon, and a fibrous rind from which the threads used in spinning are made.

When the flax is ripe the plants are pulled up by the roots. It is then rippled, to separate the seeds from the stalks. This is done either by hand, by drawing the stalks, a handful at a time, through a kind of large iron comb, called a ripple, which pulls all the seeds off, or by machines made for the purpose. The stalks are then retted or rotted by soaking them in water, which dissolves a kind of vegetable glue or sap and thus loosens the fibres from the boon. The next thing is breaking, by which the fibre is separated from the boon. The flax brake has a wooden handle, which works up and down on a board. The under side of the handle and the upper side of the board are grooved, those of the handle fitting into those of the board, so that when the stalks of flax are squeezed between them the woody part is crushed, but the fibres of the bark are not broken. The brake is worked by means of a treadle, pressed by the foot of the workman. The hand brake is much used in Russia, Holland, and Belgium, but in most other countries the breaking is done by steam machinery. The boon, or woody part, is now separated from the fibre either by beating the stalks with a broad flat wooden blade called a scutching blade, or by a machine called a scutching machine.

The rippling, retting, breaking, and scutching of flax are usually done near where the flax is raised. The fibres are then tied up into bundles and taken to the mills, where they are prepared for spinning into thread. Flax fibres vary from twenty-six to thirty-six inches in length. The part next to the root is coarse and strong, the middle part finer and not quite so strong, and the top part still finer and weaker. The fibres are therefore divided into three lengths, from which threads of different fineness are made. This is done by a machine which pulls them apart, instead of cutting them, as this makes them better for spinning. The next thing is hackling or heckling. The hackle is an iron comb, with sharp teeth, through which the workman draws the flax by handfuls. This combs the threads straight and takes out all the coarse and broken ones, which are called TOW. Hackling is now done by machinery in most of the large mills.

The hackled flax, which is called line, is now sorted or separated by hand, the different thicknesses being put into separate places in a sorting box. The sorted fibres are next spread in rows upon a long cloth, called a feeding cloth, one row partly overlapping the next one, and passed between heavy iron rollers, which make them longer and press them flat. After this, which is called spreading, the flax fibres are taken in tin cans to the drawing frame, in which the fibres are joined together at the ends, and made into one length. Lastly, they go to the roving frame, where they are twisted slightly, and wound upon BOBBINS ready for spinning into thread. In the United States some flax is raised for making twine and linen thread, but most of it is grown for its seed alone, of which about thirteen million bushels are produced yearly. The flax fibre is made into water-pails, wash-basins, slop-jars, etc., which are very strong and durable.

The word flax is from the Anglo-Saxon *fleax*, flax.

FLEA. The shape of the common flea is shown in the picture, which is magnified many times larger than

life. Its color is a reddish-brown. Its back is covered with horny scales, which lap over each other like shingles, and which form a shield so strong that much pressure is needed to crush it.

The head is small for the body, and has two small feelers, which the flea always shakes when it is moving, but which it keeps quiet, as in

Flea.

the picture, when it is at rest. The beak with which it pierces the skin is a kind of sheath, having inside it a tube, and carrying two long sharp lancets, with edges like saw teeth. With these the flea cuts the skin, and it then sucks the blood through the tube.

Like other insects the flea has six legs. The two hindmost ones are very long and strong, so that it is able to make great leaps, sometimes two hundred times the length of its own body. If a lion could jump as well, it would go two-thirds of a mile at each leap. The flea will also jump as high as two hundred times its own length, and its strength is very great. Some wonderful exhibitions have been made with "educated fleas" which were taught to draw a little cannon and a carriage, and to do many tricks. The cannon was made of gold and had all the parts of a real cannon. It was placed on a plate of glass, and two flea horses were harnessed to it by a gold chain, which was fastened to the thighs of their hinder legs. Two other fleas drew a little gold carriage with four wheels, and a third one sat on the coach-box and held a splinter of wood for a whip. The cannon and the carriage were each much heavier than the fleas, yet they were drawn with ease. Thirty other fleas were taught to go through a military exercise, standing on their hind legs, and holding up little splinters of wood for guns. All these fleas knew their master, and did what he ordered them to do. Sometimes they got lazy and would not act, but they were at once waked up when their master waved a burning coal near them so that they felt the heat. They were fed by being put on a man's arm, where they filled themselves with blood.

The flea lays ten or twelve white oval eggs, dropping them between the boards of floors, in the cracks of old furniture, or among dirty clothes. She puts with them some little black grains of dried blood for the young to feed upon when born. In four or five days tiny white larvæ or worms come out of the eggs, but they afterward turn red, and in about a fortnight each one spins a silky cocoon around itself, and in this it turns into a pupa (see INSECT). In another fortnight each pupa turns into a flea.

There are several kinds of fleas, some of which live on the blood of man, while others are found mostly on animals such as the dog, cat, fox, and squirrel, each of which has its own kind of flea, but they are all much alike in looks. Dogs troubled with fleas should be washed in strong soap-suds, weak tobacco water, petroleum water, or carbolic acid and water, every few days until they are driven off. If this does not do, rub in "Persian insect powder" all over the skin. The dog should be washed soon after using this.

The flea belongs to the order *diptera*, or two-winged INSECTS.

The word flea is from the Anglo-Saxon *fled*, flea.

FLINT, a kind of quartz rock. It is usually of a dark bluish color, but is sometimes light brown, yellow, or nearly white. It is found generally wherever there is chalk. Flint may be easily split into pieces with a very sharp edge, for which reason it was

much prized by the Indians, who made their knives, axes, and spear and arrow heads out of it. Before lucifer matches were known, a piece of flint and a steel were used to strike fire with, the spark being caught in tinder and blown into a blaze. In old times also all kinds of guns and pistols had flint locks, made of a flint fastened tightly in the hammer and a piece of steel on which it struck fire when the trigger was pulled. The sparks were caught in some gunpowder in a little hollow iron pan on the side of the gun barrel, into which the touch-hole opened, and the powder inside the barrel was thus fired.

Flint is used to some extent in the manufacture of PORCELAIN, being first burned, then thrown into cold water, which cracks it into small pieces, and afterward ground to powder. It was once largely employed in making flint glass, which took its name from it, but sand has now taken its place.

The word flint is Anglo-Saxon.

FLOUNDER, a flatfish of the same family with the sole and the halibut. The common flounder or flatfish is found all along the Atlantic coast from Chesapeake Bay northward to Labrador. It is generally ten to twenty-two inches long, and of a dull slate to a blackish-brown color. It always lies on the bottom where, when at rest, it buries itself in the mud or sand. The flesh is solid, white, and of good flavor. Many are sold in New York markets in winter.

FLOUR, the finely ground meal of wheat or other grain. The goodness of wheat flour depends much on the kind of wheat used and much on the way in which it is ground. In making it millers usually mix together different kinds of wheat, so that all the flour may be alike. The machinery of flour mills is usually run by water, but sometimes by steam-power. The grain is cleaned before grinding by passing it through machines where a blast of air blows out all the dust and chaff. It is then run into funnel-shaped boxes called hoppers, from the bottom of which it drops little by little between the grinding stones, the upper one of which turns round on the lower one. These have sharp-edged grooves cut in them, and the grain is ground to powder between them. The stones are boxed in to keep the flour from being wasted, and a blast of air which blows between them takes out the flour as fast as it is ground and keeps the stones from getting too hot.

After grinding, the flour goes to the dressing or bolting machine. This is a long kind of barrel, covered on the outside sometimes with wire gauze and sometimes with silk gauze. One end of it is lower than the other, and its gauze cover, which is very fine at the higher end, grows coarser and coarser toward the lower end. The bolt is made to turn round very fast, so that when the flour goes into it, it passes little by little down to the lower end, sifting through the gauze as it goes, the finest through the top and the coarser kinds further down, each falling into boxes made for it, until at the lower end nothing but the bran is left. The flour is then put into sacks or barrels for market. The finest flour is called the best, but as it is almost all starch it is not quite so good for food as that which has in it some of all parts of the grain. The best flour now made is called "new process flour," because it is made in a new way. Vienna bread is made of it. Graham flour is made of the whole grain ground fine, and, if well made, is better than the finest and whitest flour, but what is often sold for Graham flour is only the bran ground over again.

Flour is also made from other grains than wheat, such as rye, barley, rice, oats, and corn, but no flour is so good for food as that from wheat. Bread made from rye and barley flour is dark-colored, and

usually heavy and coarse. The flour of oats and corn is commonly called meal. In some countries flour is sometimes made out of potatoes, peas, acorns, and chestnuts, and in Sweden and Norway out of a kind of white or cream-colored powder called berg-mehl (German *berg*, mountain, and *mehl*, meal) or mountain flour, so called because it is found upon the mountains. It is nothing but the powder of little shells which perhaps have been lying there for thousands of years. This shell flour is mixed with grain flour in times of scarcity, and helps to make the loaves of bread larger. The Laplanders, Icelanders, and other people in the far North grind up reindeer moss and mix it with their flour.

Flour is so called because it is the flower or best part of the grain.

FLOWERS. In the article PLANT, which should be read before this, is told how the sap, which rises up from the roots through the stem, causes the plant to grow. This same sap, which forms buds and green leaves, makes flower buds also, and the many colored flowers which grow out of them. We do not know exactly how all these different colors are made. The stems and the buds of flowers are generally green, and the sap in them looks just like the sap in any other part of the plant, but for some reason when the bud bursts into bloom the flower is very different in color from the leaves. In some plants there are many colors in the same flower: for instance, the tulip is often striped and variegated, and the pansy, the petunia, and the China pink have several colors side by side. The light probably has much to do with making the colors of flowers, for they usually change a little as they open. The flower of the COTTON plant changes much after opening, and the flower of a vine called the cobea changes from pale green to bright purple.

Flowers are very interesting to us. We admire them for their shape, their colors, and their smell; they give us, too, many useful things, such as perfumes, honey, and medicines; and many small animals, such as bees, butterflies, and humming-birds, get much of their food from them. But we must not forget that the principal use of the flower is to form the FRUIT and the seed, and thus to make new plants. To understand, then, how a plant makes fruit and seeds it is necessary first to know all about its flower. Different kinds of plants have different kinds of flowers, but all are alike in some things. Some flowers are perfect, and some are imperfect, or wanting in some of the parts of a perfect flower. We will take a morning-glory as an example of a perfect

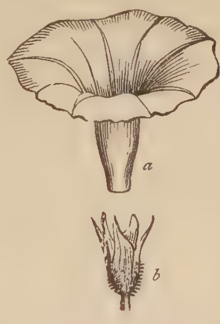


Fig. 1.—Flower of Morning Glory.
a, Corolla; *b*, Calyx.

flower, in which the parts may easily be seen. It is made up of outside flower leaves and of an inside part, which is shut in by the flower leaves. The flower leaves are of two kinds, the upper part, of some other color than green, and a little cuplike part, in which the upper part sits, and which is usually green and leaflike, In the picture these are shown apart. The upper part, *a*, Fig. 1, is called the corolla (Latin, a small crown), and it is the most showy part of the flower; the lower part, *b*, is called the calyx (Latin, flower-cup), because it is the cup in which the true flower sits,

In the second picture, Fig. 2, the corolla is shown split down and spread open so that the inside can be seen. The five little upright things are called stamens (Latin, *stamen*, the standing thing, from *stare*, to

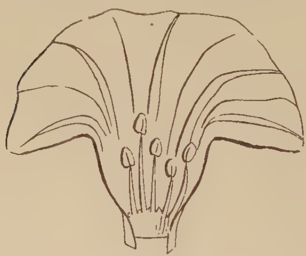


Fig. 2.—Flower of Morning Glory. Corolla cut and spread open.

stand), because they stand up inside the corolla. A stamen is made up of two parts, a stalk called the filament (Latin, *filum*, a thread), and a little hollow thing on its top called the anther (Greek, *antheros*, flowery), which is filled with a powdery matter called pollen (Latin, fine flour). Inside the stamens, and surrounded by them, is the pistil (Latin, *pistillum*, a pestle), so called because it is shaped like a pestle. The morning glory has but one pistil, shown in Fig. 3, where it is enlarged so that the parts can easily be seen; but some flowers, as the rose and the buttercup, have a great many. The pistil has three parts: the round part at the bottom, which is fastened to the stem, is the ovary (Latin *ovum*, an egg), so called because it holds the seeds or eggs of the plant; this grows above into a slender stem called the style (Latin, *stylus*, a stake), which bears on its top a roughish head called the stigma (Greek, a mark made by a sharp instrument). Upon this stigma, which is moist and a little sticky, some of the pollen, from the anthers on the ends of the stamens, is sure to fall when the wind blows, and stick fast to it, and this causes the seeds in the ovary to ripen. We do not know exactly why this is, but we do know that if some of the pollen of a flower does not fall on its pistil, its seeds will be useless; that is, they will not grow if planted. The pollen is often carried to stigmas by humming-birds and by bees and other insects. It is said that this is done to the flowers of white clover by humble bees, and that the white clover planted in New Zealand would not bear any seeds until humble bees had been carried there from England.

Fig. 3. Pistil of Morning Glory Flower—enlarged.

The calyx, corolla, stamens, and pistils make up all the parts of a flower, but in many flowers the parts differ much. In the morning glory the calyx is made up of five separate leaves, which can be pulled off one at a time. Each one of these leaves is called a sepal. But in some flowers all the sepals are so grown together that if one be pulled the whole calyx will come off. The corolla of the morning glory is formed of one piece, but in most flowers the corolla is made up of several pieces, each one of which is called a petal. The corolla of the rose has many petals. Some corollas have the petals of the same shape and of equal size, as in the strawberry, but some are irregular and have curious forms: some being like bells, trumpets, wheels, stars, etc., and some looking much like insects, such as butterflies, bees, and spiders. The stamens and the pistils, too, of plants differ much both in shape and in number; and some plants, like the snowball, have neither stamens nor pistil, and, of course, can bear no fruit.

Many flowers do not have all the parts. The lily has no calyx, and the mignonette no corolla. In some the stamens are found in one flower and the pistil in another, both on the

same plant, as in Indian corn; and in others the stamen-bearing flowers are on one plant, and the pistil-bearing flowers an another, as in the red maple. Where the stamens and the pistil are separated the pollen is carried to the stigma sometimes by the wind and sometimes by insects. Bees and humble bees get pollen on their legs and bodies when they are seeking for honey, and thus carry it to the pistil-bearing plants. Pollen is sometimes carried by the wind hundreds of miles.

After a flower has blossomed, the corolla, the stamens, and generally the calyx, fall off or wither away; but the ovary of the pistil remains, grows larger, and in time becomes the FRUIT.

Flowers have different habits, as well as colors and shapes. In most plants the flowers bloom at all hours of the day, and when opened stay open, even during night, till they fade; but some, like the tulip, the pond-lily, the sunflower, the dandelion, and the mountain daisy, shut themselves up at night and open again in the morning. The dandelion also shuts itself up often in the daytime, when the sun is very hot. The flowers of the salsify or oyster plant, which look much like those of the dandelion, close at noon and open again in the morning. Another flower, commonly called "go-to-bed-at-noon," acts in the same way. The flower called "four-o'clock" opens about four in the afternoon, and the evening primrose at evening. Some flowers open only at night. The night blooming cereus blooms for only a few hours and then wilts and dies before morning. The beautiful scarlet flower of the cypress vine, too, lasts but a few hours, opening in the morning and closing forever in the afternoon, but a new set of blossoms appear each morning. The habits of the morning glory are the same as those of the cypress vine. Spring flowers are generally small and delicate, but sweet. The flowers of summer are larger and more plentiful and have brighter colors; they are also very sweet and load the air with odor. The flowers of autumn are bright and showy, but have little fragrance.

The smell of some flowers is very sweet, of others very unpleasant. In some the smell is the same all the time the flower is open, but others give out odor only at night. The hyacinth smells sweet all the time, but about eleven o'clock at night its odor becomes so strong as to fill the room with fragrance. A few flowers are eaten and a few used in dyeing; but their chief use is in making PERFUMES.

The word flower is from the Latin *flos, floris*, a flower.

FLUORINE, one of the ELEMENTS. It is found in nature in many places, but in small quantity, and always mixed with other elements, especially with calcium in the form of fluor-spar, or Derbyshire-spar. Cryolite, a mineral brought from Greenland, is made up of fluorine, sodium, and aluminum. Fluorine has never been obtained free from other elements, though many have tried to separate it. Some of the compounds of fluorine are used for preserving food. Hydrofluoric acid is used in etching glass.

Fluorine or fluorin is named from fluor, from Latin *fluere*, to flow, and *in*, because it is found chiefly in fluor-spar.

FLUTE, a wind musical instrument much used in ORCHESTRAS and bands. The flutes of the ancient Egyptians were like those of the present day, but those of the Greeks and Romans were played by blowing in the end, like the modern CLARINET. This kind of a flute was played until the last century, and was called the English flute. It was finally given up for the German flute, which is the one most in use now. The Boehm flute is named from Theobald Boehm, flutist to the King of Bavaria, who made the first one about

1833. It is much like the German flute, but has more and different keys, which make it more perfect in tone. The piccolo is a small flute, whose notes are higher than those of the common flute. It is very shrill, and is used only in large orchestras or military bands.

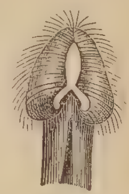
The word flute is in Italian *flauto*, and comes probably from the Latin *flatus*, blowing, from *flare*, to blow.

FLY. There are many thousand kinds of flies, all which are alike in having only two wings; the two little threads with knobs on the end behind the wing, called balances, taking the place of a second pair, and a horny or fleshy proboscis, or long tongue, with which they lick up their food.

The common house fly is found wherever man is. It comes with the warm weather and stays until killed by the cold; but some are saved during the winter, in warm places, and from these are raised the swarms which fill our houses in summer. Flies are usually most numerous around stables, because their early days are passed in dung. The females lay in it their eggs, generally more than a hundred, which are hatched in twenty-four hours, and the larvæ, or little worms hatched from them, called maggots, grow up in it until they turn into flies. The maggots are little white thin-skinned worms, without any feet. They change into pupæ (see INSECT) without casting off their skins, and in about fourteen days come out of the pupa-shell perfect flies.

All house flies are of about the same size; the very small ones and the very large ones which we often see about the house belong to other kinds. Among the smaller kinds are the cheese fly, which lays its eggs in cheese and makes the maggots that live in it. The blue-bottle fly, which is one of the large kinds, lays its eggs in meat, and therefore is found mostly around slaughter-houses and butcher shops.

The common fly is a very interesting thing when looked at under the MICROSCOPE. The wings are so thin and delicate that one can see through them, and are divided by little veins. The eyes are on the top of the head, and each one is made up of 4000 very small six-sided eyes set closely together. The proboscis or tongue is a wonderful instrument. It is between the antennæ, or two little horns that stick out in front and which serve as feelers, and is bent up underneath the head when at rest. When the fly lights on a lump of sugar, it unbends its tongue and stretches it out, and the broad knob-like end separates into two flat leaves, with which it laps up the sweets. These leaves which are shown in the picture, are strong muscles, and have little hairs on them, which make them rough like a rasp. It is these which cause the tingling feeling in our skin when a fly lights on the hand or face to sip the perspiration. There has been much dispute as to the reason why flies and many other insects are able to walk up smooth surfaces, like window-panes and on ceilings, with the head downward, as the soles of the feet are closely set with bristles. It is now thought that a little disk at the end of each hair acts like a sucker (see AIR), a thin liquid which comes from the bottom of the feet making them air-tight, and that the pressure of the air on the outside keeps the fly from falling.



End of Fly's Tongue.

People often ask what flies are made for, but if it were not for this little insect the death rate of our cities and towns would be much higher than it is. Flies deposit their eggs in every animal as soon as it is dead, and the maggots feed upon it, and thus act as scavengers, purify-

ing the summer air by using up all sorts of decaying things, which, if left to putrefy, would bring cholera, dysentery, typhoid fever, and other diseases. It is said that a single fly by means of her progeny can devour an ox quicker than a hyena can.

So the fly is one of man's best friends instead of being a pest as it is usually considered.

The **Tsetse Fly,** of Africa, is not much larger than the house fly, but it is such a pest that it keeps a large part of that country from being visited. This fly does no harm to man, the mule, the ass, the pig, the goat, or to wild animals, but its sting is sure death to the horse, the ox, the sheep, and the dog. These flies live only in certain places, and when herds of cattle are driven through the parts where they are, and they travel only by night, the cattle have to be smeared over with dung mixed with milk, which the tsetse dislikes.

The fly belongs to the order *diptera*, or two-winged INSECTS.

The word fly is from the Anglo-Saxon *fleóge*, a flying insect, from *fleógan*, to fly.

FLYING SQUIRREL. This animal is much like other squirrels both in looks and in habits, but has a kind of skin so stretched between the fore and hind feet, that in leaping from one tree to another it is kept up as if it had wings. The flying squirrel does not really fly, but sails from one tree to another, being kept up by its skin just as a man is held up in the air by a parachute (see BALLOON), and steered by it as by a rudder. When it wishes to go from one tree to another, it runs quickly up to the top of the first and springs off, at the same time spreading its legs out wide so as to stretch the skin between them, and sails downward, sometimes going more than twice as far as the height of a four-story house. When it comes near the next tree and wishes to alight, it turns upward, and the force with which it is going carries it up again about a third as far as it came down, until it catches on the limb it wants. It then runs up to the top of that tree and leaps off in the same way, and thus travels through woods very quickly. It is seldom seen in the daytime, but usually comes out at sunset and leaps playfully from tree to tree far into the night.

The flying squirrel is found throughout the Eastern United States, from Canada to the Gulf of Mexico. It is eight or ten inches long, and is yellowish-brown above and white below. It builds its nest in the hollows and crotches of trees, and has four to six young, usually in May. Sometimes six or seven live together in the same nest, and many more than that are sometimes found in the same hollow of a tree. It lives chiefly on nuts, grains, and seeds, but eats also young birds and eggs.

The flying squirrel may easily be tamed, and it makes a gentle and pretty pet, allowing itself to be carried around in its master's pocket; but as it is lively only at night, it is not so interesting as the gray squirrel. It may be treated and fed in the same way as other squirrels.

The flying squirrel is a MAMMAL of the order *rodentia*, or gnawing animals, and of the SQUIRREL family.

FOG, a body of watery vapor in the air, differing from CLOUDS only in being nearer the earth. It is caused by the union of a body of cool air with another body which is warm and damp. Clouds are formed when this happens high up in the air, and fog when it takes place near the earth. Fogs are formed also when streams of warm damp air blow over bodies of colder water or earth. All real fogs are damp; the haze, or dry fog, as it is sometimes called, often seen in Indian summer, is not a fog, but only the smoke of great prairie or forest fires driven from the west by the winds. Mist is something between fog and RAIN.

The word fog is probably from the Danish *fog*, spray, shower, drift.

FOIL, a thin leaf of metal, thicker than leaf metal, such as gold leaf and silver leaf, and thinner than sheet metal. There are two kinds of foil: tin foil, which is used for silvering the backs of MIRRORS, lining tea caddies and other boxes, wrapping up tobacco, coating Leyden jars (see ELECTRICITY), covering the roller of the PHONOGRAPH, and many other things; and the bright foils of different colors used by jewellers to put under real or false gems for adding to their brightness, and by actors as tinsel for their dresses, crowns, etc.

Tin Foil is sometimes made by rolling out blocks of pure tin to the right thickness in powerful machines, and sometimes by making the tin into a roll, and turning it round slowly against a knife which shaves off a thin sheet all around it.

Jewellers' Foil is made of sheets of silvered copper rolled very thin, and colored of the right colors to suit the gems under which it is to go, as blue for sapphires, lake or carmine for rubies, green for emeralds, etc. After the colors are put on, the foil is varnished and highly polished. Much of this kind of foil is used in making toys, and for covering cards on which pearl buttons are sewed to be sold.

The word foil is from the Latin *folium*, a leaf.

FOOD. The human body is all the time changing in some way. Every action of the MUSCLES, every beat of the heart, every breath that is drawn, weakens some part of the body and wears away some of the strength. A very short time therefore would be needed to wear out the body if there were not some means to build up all that is wasted. This is found in the food and drink which we take daily. As the different parts of the body are made up of different ELEMENTS, a variety of food is needed to supply them. Some kinds nourish the blood, some strengthen the muscles, and some build up the bone. Man cannot live on one kind of food alone, but must have all of several classes of food, mixed together in the right proportions.

Water and Salts. Of these classes of food, in which drink is included, water and the mineral SALTS are important. The human body is made up of about three-fourths water and one-fourth solid matter. A great deal of this water is all the while passing off through the pores of the skin and in other ways, and has to be made up through the food and drink. We take in more water with our food than with our drink, for all animal and vegetable food is largely made up of water. Of the mineral salts in our food, chloride of sodium, or common salt, which is needed by the blood, and phosphate of lime, which builds up the bones, are the most useful; but there are also some others, called alkaline salts, which are needed for our health.

Starch and Sugar. Another important class is made up of STARCH and SUGAR, which are so nearly alike that the one may be easily turned into the other. We get these from vegetables mostly, though milk has in it a little sugar. All the cereals, or grains used for food, potatoes, peas, and beans, give us starch; and we get sugar not only from cane juice, but from all the sweet juices of fruits and vegetables. We could not live without this kind of food. Those who have to live on animal food without fresh vegetables are often attacked by scurvy and other diseases. Starch and sugar are called carbonaceous foods, because they are made up principally of CARBON.

Fats. Another class of foods are the fats, which also are called carbonaceous foods. They are made up, like starch and sugar, of carbon, hydrogen, and oxygen, but mixed together in different proportions

We get fat from both animals and vegetables. Olives and most kinds of nuts have in them a good deal of oil or fat. Indian corn, wheat, and other grains also contain some. Butter is the fat of milk; and at least a quarter of the yolk of eggs is oily fat.

Albumens. The last class of foods are the albuminoid substances, so called because ALBUMEN is the principal one of them. They are also called nitrogenous substances, because, while they have in them carbon, HYDROGEN, and OXYGEN, like starch, sugar, and fat, they have also NITROGEN, which the others have not. This is an important difference, for without nitrogen men and animals could not live. We are all the time taking in nitrogen with our breath, but not any of it stays in the body; it is all breathed out just as it went in. The nitrogen which goes into the blood, and which helps to build up our wasted strength, is taken in with the food. The principal nitrogenous foods are albumen, which forms the white of egg and makes up a large part of the lean of all meats; caseine, which is found in milk, and is the chief part of CHEESE; legumine, which is a kind of vegetable caseine, found in beans, peas, and other pod vegetables; and GLUTEN, which is in all grains used for food.

The milk on which infants are fed is made up of water, mineral salts, sugar, fat, and caseine. It therefore has in it all things needed to sustain life, and this is why children thrive on it. As man grows older he needs all these things just as much as he did in infancy, and unless he is careful to supply himself with the different kinds of food, he cannot keep up his health and strength.

The word food is from the Anglo-Saxon *foda*, nourishment.

FOOT, measure of length, at first the length of a man's foot. The English foot contains 12 inches and is equal to 30.48 centimetres of the metric system. The ancient Roman foot was a little shorter, being 11.65 inches; the Attic foot was about the same. In modern Europe the foot has varied in different countries, from about 11 inches (Spain) up to over 20 inches (Piedmont).

The word foot is from the Anglo-Saxon *fot*, foot.

FORGE. The hammering of red-hot iron or steel into shape is called forging, and the workshop in which it is done is called a forge. The most common forge is that used by blacksmiths, shown in the picture. It is made up of a broad stone

Blacksmith's Forge.

hearth, raised about as high as a table, in front of the chimney, on which the fire is kept burning all the time. When not in use, the fire is usually kept covered up with ashes, but it can easily be made bright by raking it open, and blowing the great leather bellows seen behind the chimney. The curved handle of the bellows is above the anvil. When the blacksmith works this handle up and down, a blast of air is blown through a pipe which leads from the bellows through the chimney, and as this carries a great deal of OXYGEN into the fire, it blazes up and becomes hot enough to heat metals

very quickly. The iron hood over the fire catches sparks and smoke and carries them up the chimney. In front of the hearth is an iron trough full of water, in which the smith cools hot iron, and thus hardens it. At the right of it stands the ANVIL, on which he hammers and shapes things; and hammers, sledges, and other tools used by him are seen lying around.

In forges where shovels, spades, axes, scythes, and other tools are made, bellows worked by steam-power are used, and the iron or steel is generally hammered with tilt HAMMERS instead of by hand. There are also very large forges, where great masses of metal, such as the shafts of steamships and other parts of machines, are forged under great steam hammers which pound the red-hot metal into shape. In such forges the metal has to be moved from the fire to the anvils by means of CRANES. Portable forges are small forges which may be moved from place to place. They are much used in ship building, boiler making, and by armies in the field for mending iron-work, such as the parts of wagons, cannons, etc.

The word forge is from the Latin *fabrica*, the workshop of a *faber* or smith.

FORK. The ancients had no forks, but ate with their fingers, holding their meat with the left hand while they cut it with a knife in their right. Forks first came into use in Italy about the fifteenth century, but they were not generally adopted until about two hundred years ago.

The word fork is from the Anglo-Saxon *forc*, Italian *forca*, Latin *furca*, fork.

FOUNTAIN. Water may be made to jet or spout up above the natural level of the ground in three ways; 1, by having the fountain joined by pipes with a reservoir of water higher than the fountain; 2, by pumping up the water; and 3, by using some natural spring. Fountains working on the first plan are the most common. The height to which they will throw their water depends on the height of the reservoir which feeds them, for as WATER always seeks its level, that which spouts from the pipe of the fountain will try to get up as high as that in the reservoir. If the pipe reached up higher than the water in the reservoir, the water in it would go just as high as that in the reservoir; but as the pipe is usually much shorter, the water can only leap up part of the way, when the force of gravitation, by which all things are drawn toward the earth, pulls it back again, and it falls into the basin and runs off through the drains under the fountain.

The height to which water may be thrown by the second kind of fountain depends on the power of the pump beneath, which is usually worked by a steam engine. The third kind of fountain is generally seen at mineral spas or springs, where the natural force of the spring is used to throw up the water. The drinking fountains in the parks and streets of cities are supplied from the same water pipes which carry water into houses.

The word fountain is from the Latin *fons, fontis*, a fountain.

FOWLS. The word fowl properly means any kind of bird, but in common language it is given to poultry, or any barnyard bird, such as cocks and hens, turkeys, ducks, geese, swans, and pigeons. In this article it will be understood to mean only cocks and hens; all the other kinds of fowls being told about under their own names. It is supposed that common fowls came first from India or from some of the islands of Asia, where many wild kinds are still found; but our tame fowls are not exactly like any of the wild kinds. Fowls have been kept in almost all countries from the most ancient times, and there are now many different breeds. Besides the common

dunghill fowl, the principal kinds are the Game, Dorking, Poland, Black Spanish, Chinese and Malay, Hamburg, Dominique, and Bantam.

Dunghill, or common barnyard fowls, are supposed to be a mixture of many breeds. They are of many different colors, sizes, and shapes. The cocks usually have very large combs and wattles. Some have yellow legs and some black legs, but the yellow-legged ones are the best. Many people think that these common fowls are as good for laying and for eating as any of the other kinds.

Game fowls are much like common ones in form, but are generally a little smaller, and have more delicate legs; they are also stronger and have more courage. The cocks are very quarrelsome, and will fight until they die. On this account they are much used for the wicked sport of cock-fighting, which is a favorite amusement in the East Indies and in Spanish America, and which is sometimes practised secretly in this country, although it is against the law. In these fights the combs and wattles of the cocks are cut off close to the head, so that in pecking at each other there shall be little to catch hold of; and long steel spurs, called gaffs, are put on over the cocks' spurs, so sharp that bad wounds are made when the birds strike each other. But game fowls are good for other things than fighting. They are strong and seldom sick, and their flesh is solid and much liked for the table. The hens lay rather small eggs, but they are good sitters, and take the best of care of their chickens.

Dorking fowls were first raised in the town of Dorking, in Surrey, England. They are of large size, good shape, and when of pure blood are white, but many are now seen speckled with black or gray. They always have five toes on each foot, instead of four like most other fowls. Sometimes the cocks have double combs. Dorkings are good layers, their flesh is white and tender, and they are easily fattened.

Poland fowls, supposed to have been first brought from Poland, are black, and have, instead of a comb, a crest of feathers on the head which is sometimes so large as to hang over the eyes. There are also other kinds called Polands, such as white Polands, which are white with black topknots, and golden Polands, which are mixed yellow and black with black topknots; but the real Polands are black with white topknots. They are very handsome fowls, and fine layers, but they do not like to sit, and it is always best to have their eggs hatched by other hens. They are easily fattened, and their flesh is good. Poland fowls are much raised in France and Egypt.

Black Spanish fowls were first brought from Spain. They are sometimes called Fayal fowls, because many are raised in that island. They are quite large, with black feathers, which are very dark on the lower parts, and they have lead-colored feet and legs. Their combs are very large and often hang over on one side, and they have a white patch of naked skin behind the ears. They are fine layers, laying larger eggs than the Polands, and their flesh is excellent for the table.

Chinese and **Malay** fowls include Shanghais, Cochin Chinas, Chittagongs, and Brahmapootras. The Shanghais, which came from China, are much like the Cochin Chinas, which were brought from the country of the same name. They are much larger than common fowls, and are awkward in shape, having long bony legs and short wings and tail. Some are yellow or cinnamon colored, some black, and some white; and while some have feathers on their legs, others are barelegged. The Cochin Chinas are usually reddish-brown. Both these kinds are hardy and easy to raise, and good layers and sitters. Their

eggs are light brown or buff. The Chittagongs or Malays were first brought to this country from Malacca, but they probably get their name from Chittagong in India. They are quite large, with heavily feathered legs, and are usually brown, streaked with yellow or white. They are good layers, and their eggs are very large. Their chickens are easily raised. The Brahmapootras, named from the river Brahmapootra, in India, are large gray fowls, and are thought by some to be part Shanghai and part Chittagong. They are fine layers, lay very large eggs, and are good sitters and mothers.

Hamburg fowls, sometimes called Bolton Grays, are very pretty fowls, silvery-white speckled with black, and are much valued both for their flesh and eggs. Dominique fowls are also speckled. They are rather small, but are good layers and their flesh is much liked.

Bantam fowls are named from the town of Bantam in Java, but they were first brought from India. They are very small, usually weighing only about a pound apiece, but they are very courageous. A bantam cock will whip a dunghill cock of five times its own weight. There are a good many kinds, most of them having feathered legs. The Seabright bantam is a beautiful bird of mixed colors, with smooth legs, first raised by Sir John Seabright. There is a kind which has a topknot, like the Polands, and another which is not larger than a pigeon. Bantams make very pretty pets, and they lay well, but their eggs are quite small.

Besides these, there are many fancy kinds of fowls, which are kept chiefly as curiosities. Among them are the creepers, with very short legs; the Persian or rumpless fowls, without tails; the Friesland, frizzled, or crisped fowls, with feathers turned toward their heads; the silky or merino fowls, covered with a kind of down instead of feathers; and the negro, with black comb, wattles, legs, and feathers.

Laying. Fowls lay more eggs than other kinds of birds. Chickens usually begin to lay the next spring after they are hatched. When a hen begins to think about laying, her comb and wattles grow red, and she cackles often. She then looks for a nest, and after she has found one to suit, generally in some quiet place where she can hide herself, she makes a little hollow in it and soon begins to lay. Some hens will lay an egg every day and some, one every other day. Eggs ought to be taken out of the nest every afternoon, for if left for several days the heat of the hen's body warms them every time she goes to lay, and they will not keep so long.

Sitting. After laying fifteen or twenty eggs a hen begins to flutter about with her feathers ruffled up, and clucking as if she had chickens. This shows that she wants to sit, and if a nest be made for her and eggs put into it, she will stop laying, go on to it and sit; but if her eggs are taken away from her as fast as she lays them, she will keep on laying until about the middle of summer, when she will stop for a few weeks. She will begin again at the close of summer and lay until the middle of winter, when she will stop a second time. When properly fed and taken care of, a hen ought to lay more than a hundred eggs in a year; but as hens are usually treated they do not lay more than thirty to forty eggs a year.

The number of eggs to be given a hen when she sits depends on her size; if she is large she can cover eleven to thirteen, but if of common size, nine will be enough. It is usual to take an odd number because they will lie better in the nest, one in the middle and the others around it. When sitting, hens should have food and fresh water put near them every day. Some will come off the nest

and eat every day, and some will sit sometimes two or three days without coming off the nest. On the twentieth day the chickens will chip the shell and come out of the egg. As soon as all are hatched the hen leaves the nest with her brood, and at once begins to scratch and feed the little ones. The cock, too, often aids her in taking care of them, and sometimes, when a hen has been killed, a cock has been known to raise the motherless chickens himself, brooding them at night and giving them the best of care by day. Chickens will begin to eat very soon after leaving the egg, but it is best usually not to feed them until the next day, when a few crumbs of bread or a little hard-boiled egg may be given them. For a few days they will need but little food, but after two or three weeks they should be fed four times a day. When the hen comes off the nest with her brood, she should be put into a coop, with bars in front so that the chickens can run in and out. In warm, pleasant days this may be put in some dry place in the garden or on the lawn, but in cold or rainy weather it should be moved into some sheltered place, such as a barn or outhouse. Care must be taken that cats, rats, and weasels do not get at them, as they all like young chickens. A weasel will often kill a whole brood in a night. In about seven weeks the chickens will leave their mother and earn their own living, acting like grown-up fowls and going to roost with the others by night.

Care of Fowls. Fowls should have a warm dry place to roost in, where they can get fresh air, and a large playground. If they are kept shut up in a small yard, part of it should be covered with grass and part with gravel, and they should have a good supply of pounded oyster shells, egg-shells, or old mortar given them, as lime is needed to form the shells of their eggs. They should also have a box of ashes, sand, or dust, to roll in, as this is necessary to rid themselves of vermin. They like any kind of grain, and sunflower and flax seeds are also good for them. Grain is best for them when boiled, and they will eat also almost any boiled vegetables. The best way is to give them a box of mixed grains, with openings in the top, wide enough for them to get their heads in. They can then always get food when they want it, and they will not eat as much as if they are fed only at regular times. If kept in a close place, they will also need worms, insects, or some kind of fresh meat. They should always have a plentiful supply of pure fresh water.

Any child can easily learn to take care of fowls, which make very pretty and interesting pets. In buying them it is best to get a cock two years old, and hens in their second year. Hens are best from three to five years old; after their fifth year they do not lay so well. In picking out hens, take those with bright eyes and small bright red combs. Hens that have large combs, and which try to crow are not good for much. The cock should be bright, lively, and handsome, with clean, well-kept feathers, and a proud air. An old one can be told by the dulness of his feathers, comb, and wattles, and by the large scales on his legs. One cock is enough for ten or fifteen hens.

Fowls belong to the order *rasores*, or scratching BIRDS, and to the pheasant family, which includes, besides pheasants, peacocks, turkeys, and Guinea fowls.

The word fowl is from the Anglo-Saxon *fugol*, a bird, which is from *fleogan*, to fly.

FOX. The fox looks somewhat like the dog, but is not so tall. It has a sharp nose, pointed ears, slender legs, fine thick fur, and a long bushy tail. It is very shy and cunning, and usually keeps hidden in the daytime, coming out at twilight and wandering round by night in search of its prey. The fox usually lives in

a burrow which it digs in the earth among rocks, or under the roots of a tree, always in a place where the rain cannot run into it. Its house is usually in three parts; an entrance, where it lies and watches a while before coming out; a store-room, where it hides its food, and which has several openings; and behind that its sleeping place. But the fox seldom sleeps in its burrow, except when it is raising its young; it prefers to spend the night near where it can find plunder, which is often miles away from its home. It is very careful of its young, of which it usually has three to five at a time. The male and female live together until the young are able to take care of themselves, and then separate. Foxes generally live thirteen or fourteen years.

The fox is cowardly, and never attacks animals that are stronger than itself. It lives chiefly on birds, rabbits, hares, and other small game. It has a great liking for poultry, and loves to suck eggs, and also likes some fruits, especially grapes. When a fox finds a poultry yard it wanders around until it finds a weak place, and then watching its chance, goes in in the night and kills all it can catch, carrying off its plunder and hiding it in its burrow for future use. Sometimes, when fowls wander about a farm, a fox will lie in wait at the edge of a wood and carry them off, one by one. A story is told of two foxes who had a clever way of catching hares. One of them hid himself by the side of a road, and the other drove the hares into the road, barking now and then to let his companion know which way they were coming. When a hare came within reach the fox watching pounced upon it, and the two then divided the feast.

The fox is not easily tamed, but sometimes, when taken young from the nest, can be taught as well as a dog. But it will never lose its taste for thieving. A funny story is told of a tame fox that belonged to a druggist in a small town in France. Its master lived in a house on the market-place, and close by it was an eggstand, kept by a poor woman who bought eggs from the peasants, and packed them to send to Paris. Before packing, all the cracked ones were picked out and laid aside. One day the old woman, who had laid two dozen cracked eggs behind her, was astonished, on turning round, to see that they were gone. She accused her neighbor of robbing her, but the latter denied it. The next day the same thing happened, and again the third day, and though watch was kept, nothing was found out. The old woman then put her eggs under her petticoat, between her feet, but they still disappeared, and as she was sure that no one had been near enough to get them from under her, the theft was laid to witchcraft. But not long afterward the truth was found out. Behind the old woman's chair were two very small openings made to let air into the cellar of the druggist's house. They were so narrow that no one would have thought that any animal could squeeze into one of them, but one day the tame fox was seen to run out its head, seize an egg, and draw it in, and so the thief was found out.

The senses of sight, hearing, and smell are very sharp in the fox, and it can run very fast. It uses many tricks to escape its enemies, but as it has a little bag at the root of the tail filled with a very strong scent, it is easily tracked by dogs, and often run down by huntsmen with hounds. In England fox-hunting with dogs and hounds is considered fine sport. There used to be a good deal of it in the Southern States, and lately there have been several hunts on Long Island, near New York. Sometimes, when a fox has been run down by hunters, it will make believe to be dead, and may be kicked and cuffed, held up by the tail, or carried over the

shoulder without showing any signs of life; but the moment it sees a chance to escape, it will scamper away, to the astonishment of the hunters.

The principal kinds of foxes in the United States are the red fox, found chiefly in the Northern and Middle States, and the gray fox, in the Southern States. The gray fox is not so cunning as the red one, and lives usually in hollow trees and holes in rocks. It seldom steals chickens, but robs the nests of wild turkeys, and chases rabbits and other small game. The prairie fox, found in the prairies of the West, is like the red fox in color, but is larger and has finer fur. In the State of Washington is found the black fox, much prized for its fur. The nobles of Russia and mandarins of China value this fur above all others, and pay very high prices for it. The Arctic or blue fox lives in the most northerly parts of America, Russia, and Siberia. Its fur is very long, soft, and thick, and is sometimes white, but often of a gray slate color tinged with blue. It is much hunted, and there is a large trade in its skins.

The fox is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the dog family, which includes besides the dog, the wolf and the jackal.

The word fox is Anglo-Saxon.

FROG. When full grown, frogs have four legs, with four toes on the fore feet and five on the hind feet. The hinder legs are very long, so that they are good leapers, and their feet are webbed, so that they swim well. They pass their time mostly in the water, or in moist places, but in dry times often travel considerable distances across the land in search of water. All kinds of frogs live on animal food, eating MOLLUSKS, worms, and insects, but the large bull-frog, which is found only in North America, will eat moles, mice, young ducks, small snakes, and any other small animal it can catch. Frogs have very large mouths, with teeth in the upper jaw only, and long soft tongues, which they dart out to catch insects. It is their custom to sit and watch for prey, and, when anything comes near enough, they spring upon it with great swiftness. In the autumn they cease to eat, and as cold weather comes on bury themselves deeply in mud, many of them together in the same place. Thus hidden, they pass the winter in a numb state; but in the spring they get active again, little by little, and come out of the mud.

Soon after waking the female lays her eggs on the top of still water. These may often be seen in ponds and ditches in the country in the spring, floating on the water and looking like froth or air-bubbles. When looked at closely they are seen to be made up of little round masses of gluey matter, with a black speck in each. The mother leaves the eggs and pays no more attention to them. In a few days the little black spot begins to grow, and at last makes its way out of the gluey envelope and swims. It is now what is commonly called a tadpole, which has a tail but no legs, and which breathes through gills like a fish. After a time the hind legs begin to grow, and the fore legs soon follow. Then the tail begins to wither away, the LUNGS grow, the gills disappear, and finally the frog leaves the water and becomes an air-breathing land animal. In the picture are shown the different stages of growth of the tadpole, almost to the time when it becomes a frog. In 1 the tadpole is shown just before it leaves the egg, and in 2, just after leaving the egg; in 3 and 4 are seen the growth of the gills; 5 shows a further change, and 6 is a side view of the same; in 7 the hind legs are first seen, and in 8 both pairs of legs are grown, and the tail is withering away. These changes in the frog may easily be watched by gathering some frogs' eggs, and putting them with some water plants

into an AQUARIUM, or into a goldfish globe.

Most tadpoles become perfect frogs during the summer after they are hatched, but those of the common bull-frog seldom change fully until the next spring, spending the winter in a numb state, like full-grown frogs, in the mud. Snakes, fishes, and many kinds of birds feed on tadpoles and little frogs. If this were not so, all the ponds would become filled with them, for one frog will sometimes lay more than a thousand eggs.

All frogs croak, but the male frog makes the most noise. When many are singing together, their voices can be heard at a great distance. In old times, when castles and country houses in Europe were surrounded by moats, or ditches filled with water, men and boys were made to beat the water in the morning and evening to keep the frogs from croaking and spoiling the sleep of the lords and ladies.

Frogs are harmless animals, and do much good by destroying insects, slugs, and worms. The hinder legs

Growth of the Frog, showing the changes from the egg nearly to the perfect form.

of some frogs are eaten, and are much more delicate than the tenderest chicken. In some places where they are plentiful men make a living in catching them for market; and in Wisconsin a man has a frog farm where many thousand are hatched every year.

Tree Frogs are smaller, brighter, handsomer, and more lively than other frogs, and they differ from them in having little suckers on the ends of their toes, by means of which they can climb trees and even walk head downward like flies, on any smooth surface. Their skin is smooth on the back, but warty underneath. They can change their color, which helps them to escape from their enemies. The common tree frog of the Northern United States varies from ashy gray to dark brown. It is usually found on decaying trees and old fences overgrown with mosses and lichens, which are so near its color that it is hard to see it. In the Southern States most of the tree frogs are green above and yellowish below. All tree frogs make a good deal of noise in warm weather toward evening, especially before rain. In winter they bury themselves in mud like other frogs, and breed in spring,

laying their eggs in water. In the island of Borneo is a kind of flying tree frog, with very long toes, joined together with a thin skin, by means of which they can sail long distances from the top of one tree to another, in the same way as the FLYING SQUIRREL.

Frogs and TOADS are of the class AMPHIBIANS, of vertebrate animals.

The word frog is from the Anglo-Saxon *frogga*.

FROST, crystals of frozen DEW. When the watery vapor in the air is so cool that it cannot condense, or turn to water, without going below the freezing point (32° F.), it will fall to the earth in the shape of frost crystals instead of dew. This is sometimes called **Hoar Frost,** and sometimes white frost. This is different from freezing, commonly called frost, which is simply the hardening of water and moisture from the cold of winter. The frost work on the inside of window panes in warm rooms in cold weather, which sometimes takes the form of ferns or feathers of ice, is also a freezing, and not a true frost. Moisture from the warm air of the room gathers on the glass, just as dew falls on the grass, and is cooled and frozen there. But true frost is not frozen dew, that is, moisture which falls as dew and freezes afterward, but moisture which falls already formed in ice crystals. **Black Frost** is caused by a cold so severe that plants freeze and turn black, without showing any signs of hoar frost on the outside.

The word frost is from the Anglo-Saxon *forst* or *frost*, from *freósan*, to freeze.

FRUIT. In the article FLOWERS, which should be read before this, is told how the ovary of the pistil is left on PLANTS when the flower drops off or withers, and finally grows into the fruit. The fruit therefore of any plant is the part which holds the SEED, and this is always the ovary of the pistil of the flower. In common language we call only the juicy edible part fruit, but the seed-holder of the morning-glory and of the rose are as much fruits as the apple, the orange, and the walnut. After the flower withers, the stem on which it grew keeps fresh, and the sap flows along through it just as it did when the flower grew. We cannot see any difference in the sap, and we cannot tell why it stops making flowers and changes to making fruit; we only know that the same kind of sap which makes the plant grow and bear flowers causes the pistil to grow and become fruit.

Fruits grow in many different forms. A simple fruit is a seed-holder formed by the ripening of one pistil. There are three kinds of simple fruits: 1, fleshy fruits; 2, stone fruits; and 3, dry fruits.

1. **Fleshy Fruits** may be divided into berries, gourd fruits, and apple fruits.

Berries are commonly understood to be such fruits as the currant, huckleberry, strawberry, and blackberry; but strawberries and blackberries are not really berries, as will be shown hereafter. A berry is a seed-holder where the seeds are shut up in fleshy or pulpy matter, with a soft skin on the outside. Tomatoes are berries, as well as grapes, cranberries, gooseberries, currants, and huckleberries. The orange, lemon, and lime are also berries, with a thick rind or skin.

Gourd fruits (usually called pepos, from Greek *pepon*, a kind of melon) are only a kind of berry with a hard rind. All kinds of melons, squashes, cucumbers, etc., are gourd fruits.

Apple fruits (usually called pomes, from Latin *pomum*, an apple) are apples, pears, and quinces. In these the fleshy part which we eat is made from the calyx of the flower and not from the pistil. In the quince the calyx, which grows thick and fleshy, forms the whole of the body of the fruit; but in the pear and the apple the flesh of the core comes from the pistil. If an apple be cut in two

crosswise, little greenish dots will be seen running around the core; all inside of these comes from the pistil, and all outside from the calyx.

2. **Stone Fruits** (usually called drupes, from Latin *drupa*, an over-ripe olive), like berries, are made up of fleshy or pulpy matter with a skin; but their seeds, instead of lying in the pulp, are shut up in a hard shell like that of a nut. This shell or stone does not belong to the seed, but is a part of the fruit; the seed, which is inside of it, has a cover or skin of its own. Among the principal stone fruits are the cherry, plum, peach, apricot, and olive.

3. **Dry Fruits** are those which ripen without any pulp or fleshy part. There are two kinds: those which keep closed, holding the seed until they grow, and those which burst open and scatter their seed.

Those which hold their seed are principally four kinds: the akene, the grain, the nut, and the key.

The akene includes all small, dry, hard, one seeded fruits, like the fruits of the buttercup. These are commonly thought to be seeds, but when cut open the seed is found inside. Each little part of the dandelion and the sunflower, commonly called a seed, is an akene.

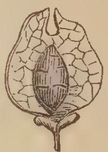
A grain is the same as an akene, but the seed, instead of being separate, is stuck so closely to the seed-holder that the two form only one part. Wheat, barley, rye, rice, oats, Indian corn, etc., belong in this class.

A nut also is like an akene, but is larger. Acorns, chestnuts, beechnuts, and hazel nuts are real nuts. In all these the nut is surrounded by a kind of cup. In the acorn this is a scaly cup in which the fruit sits; in the chestnut and beechnut it is a kind of burr; and in the hazelnut it is a leafy envelope or covering. The fruits of the walnut family, including the English walnut, black walnut, butternut, hickory-nut, and pecan-nut, are not real nuts, but are between a stone fruit and a nut.

A key or key-fruit is an akene, or any other seed-holding fruit, which has a wing. The fruits of the ash, elm, and maple are key-fruits. The ash and elm are single ones, but the maple is double and has two wings, as shown in the picture.

Single Key-fruit—Ash.

All these kinds of fruits—akenes, grains, nuts, and key-fruits—keep their shells or seed-holders closed until they decay or until the seed begins to grow, when, of course, they open to let out the root and bud. The dry fruits whose seed-holders split or burst open and let out the seeds when they are ripe are generally called pods. There are several kinds of pod fruits. Those which split down one side only, like the pods of the columbine and peony, are called follicles; those which split into two pieces, like peas, beans, and peanuts, are called legumes; and those which split into several pieces, like the pods of the lily, flower de luce, and the morning-glory, are called capsules.



Single Key-fruit—Elm.

Double Key-fruit—Maple.

Compound Fruits. All these fruits are simple fruits, made by the

ripening of one pistil. Most fruits are of this kind, but there are a few compound or mixed kinds of fruits. The raspberry and the blackberry are called aggregated fruits, because they are made up of many simple fruits aggregated or collected together. Each grain of these fruits is a really a stone-fruit, like a little plum or cherry. The strawberry is called an accessory fruit, because the fleshy part is accessory—that is, something added to the seed-holder. The juicy part which we eat is really not a fruit at all, but only the end of the flowerstalk, grown large and fleshy. The real fruits of the strawberry are what are commonly called the seeds, which are scattered over the outside of the fleshy part. Each one of these is an akene, a seed-holder containing one seed.

Another class of compound fruits are called multiple fruits, which are masses of fruits made up from different flowers. The mulberry is a multiple fruit. It looks like a blackberry, but all the grains of each blackberry come from one flower, while in the mulberry each grain comes from a different flower. The pineapple is also a multiple fruit.

The word fruit is from the Latin *fructus*, fruit, from *fruor*, I enjoy.

FUEL. Man is the only animal that makes and keeps up a FIRE. Many of the common animals, such as dogs and cats, like heat, and some of the higher apes have been seen to gather around a fire left by travellers and apparently enjoy it, but none of them has had the sense to put on fuel to keep up the fire. Wood was probably the first fuel, but man soon learned to use the fat of animals and even the oil pressed from plants; then came the use of peat and finally of coal. All races of men, even the lowest, have used fuel of some kind, and the higher man has got in civilization the more fuel he has required for his needs. If man were deprived of fuel civilization would come to an end, for he is dependent upon it not only for his comfort, but for most of the industrial and manufacturing operations in which he is engaged. Fuel drives the machinery which runs his mills and factories as well as his railroads and steamships. Until within a few years COAL has been the principal fuel of the world, but PETROLEUM or mineral oil and natural GAS are now largely used, and many people think that gas will be the fuel of the future. It is much used now in many cities of the West both for domestic purposes, such as heating and cooking, and also to drive machinery, to smelt iron, and other industrial purposes.

The word fuel is from the Low Latin *focalium*, brushwood for fuel, from *focus*, fireplace.

FUNGI, a family of flowerless PLANTS, which in their different forms are commonly called mushrooms, toadstools, smut, rust, blight, mould, mildew, and other names. Fungi are a lower kind of plants than LICHENS, but some of them are so nearly like lichens that they can scarcely be told from them. They differ from lichens chiefly in drawing their food from the things on which they grow. They are also softer than lichens, and do not live so long. Fungi usually grow in damp places, and are most plentiful in countries where the heat is not too great. They are found wherever there are decaying plants, on which they chiefly feed. Some grow very quickly, often springing up in a single night and dying with the coming of the sun, and some grow very slowly, and add to their growth each year. Some are hard like horn, some are like paper or leather, some are almost like flesh, and some are nearly like water. Some are so small they can scarcely be seen, and others will measure several feet round. Fungi have been used for food from the most ancient times, and some kinds are still much eaten.

The **Mushroom** is the most widely used for food, and is much raised in

hotbeds, cellars, and caves. Near Paris are great caves made by cutting out stones for building, and in them are immense mushrooms beds, many miles long, where great quantities are raised for market. There are several kinds of mushrooms which are good to eat, but the kind mostly eaten is the common field mushroom, which grows wild in Europe and America. It has a white, thick stem, with a fleshy cap, white above and pink underneath. It is easily told by its pleasant smell; but those who do not know mushrooms well should not gather them, as there are many poisonous kinds, usually called toadstools. Mushrooms are eaten either stewed, broiled, or baked, or are used as a flavor for other dishes. They are also made into catsup.

The word mushroom is from the French *mousseron*, from *mousse*, moss, because mushrooms often grow in moss.

The **Truffle** is a kind of fungus which grows underground like the potato. Truffles are mostly found in woods, usually where oak, beech, and chestnut trees grow. They are generally about the size of a walnut, but some are much larger; some are nearly white, but most of them are brownish and rough or watery on the outside. They are commonly found about a foot underground in loose soil, and are dug up with a hoe or pick. In England they hunt for them with trained dogs, which find the places where they grow by the scent, and point them out just as a pointer does game. When the truffle is dug up, the dog is rewarded with something to eat. In France pigs are taught to find them in the same way. No truffles have yet been found in the United States, but they abound in Europe and Africa, and many are brought to this country in sealed tin cans. They are much liked for flavoring meats and sauces.

The word truffle is from the Latin *tuber*, a swelling.

Mildew, Smut, and Rust. Some kinds of fungi grow on plants and destroy them, and are therefore much dreaded by farmers. Among the most common and most injurious are the rust and smut which destroy wheat and other grains. The mildew on grape vines, the black warts on plum trees, and the rot in potatoes are all fungi, which grow upon and in them, and cause them to decay. Fungi often grow on the skins of fruits, making the black scalylike patches seen on apples, pears, and plums. Hop vines, pea vines, Indian corn, and various other kinds of vegetables are often attacked by mildew, and rose bushes are frequently spoiled by it. Indeed, there is scarcely any plant, wild or cultivated, which is not troubled with fungi.

Mould. What is commonly called mould or mouldiness on animal or vegetable substances is made by many small fungi which grow together in a mass and soon cover any decaying thing. Mould grows plentifully on fruit, preserves, and paste, and makes them decay faster. A kind of blue mould is found on bread and cheese; it spoils bread, but is thought by some to give a good flavor to cheese. Other kinds of mould or mildew grow on linen or cotton cloth, and on paper, when kept in damp places. Paper mould is often seen on paper pasted on damp walls, and similar fungi also grow on plastered walls themselves.

The word fungi is the plural of *fungus*, which in Latin means a mushroom.

FUR, the short soft hair of animals growing next to the skin and under the hair, which is longer and coarser. Skins dressed with the fur on, and from which the long hairs have been pulled, are called furs; before being dressed, they are called pelts. Before they are fit for use skins have to be thoroughly steeped and scoured in a bath of bran, alum, and salt,

then washed in soap and soda, and cleansed and dried. The alum tans the skin into a kind of kid leather. Some furs are afterward dyed, but the only one improved by this is the fur of the seal, which is changed from a dirty yellow to a rich brown, while its hairs, which in the live animal are curly and not very smooth, become straight and of a velvety softness. All skins are of irregular shapes, and differ much in color in different parts. They are therefore cut up into pieces, and then fitted together again according to colors or tints. This needs much skill, as the pieces have to be sewn edge to edge, so that the seams will not show. A fur cloak made of a valuable fur is often made up of a great number of odd-shaped pieces.

The principal fur-bearing animals are the sable, marten, mink, ermine, beaver, otter, chinchilla, fox, seal, nutria, badger, rabbit, fisher, lynx, bear, and wolf. (See FELT and HAT.)

The word fur is from the New Latin *furra*, a hairy skin.

FURLONG, a measure of length. It is equal to one eighth of a mile or 40 rods, being 220 yards or 660 feet; and is equal to 201.17 metres. The furlong is nearly equal also to the Roman stadium.

The word furlong is from the Anglo-Saxon *furlang*, from *furh*, a furrow, and *lang*, long, and means the length of a furrow, the track of a plough across a field before it turns.

FUSTIC, a dye-wood obtained from a tree which grows in South America and the West Indies. When boiled it makes a yellow dye, which is used chiefly in dyeing cloths and yarns that have been first dyed blue, the fustic changing them to green. Fustic is brought, in the form of long sticks or logs, from the countries where it grows.

The word fustic is from the Spanish *fustoc*, fustic.

G

GALLON, an old English measure, containing four quarts, eight pints, or thirty-two gills. Formerly there were several kinds of gallons: a wine gallon (231 cubic inches); an ale or beer gallon (282); and a corn gallon (268) for measuring grain and other dry articles; but in 1825 the English Parliament established the imperial gallon (277.27 cubic inches) between the wine and the beer gallon, and this is the gallon now used in England. In the United States the gallon used is the wine gallon (231 cubic inches).

The word gallon is from the old French *galon*, a liquid measure.

GALLS, GALL NUTS, or **NUT-GALLS,** small lumps or swellings which grow on a kind of oak tree,

Nut-Galls.

chiefly in Asia Minor and Central Asia. They are made by a fly which pierces the young boughs and lays its eggs in them. This causes them to swell up into galls, in which the young of the fly live until they are grown, when they eat their way out. The best galls are those that are picked before the insect has come out; they are then dark blue or black, but after the insect has left, the galls become white. Galls are usually from the size of peas to that of nutmegs, are hard and brittle, and covered with knobs. They have in them an ACID called gallic acid, which is very useful for tanning leather, and they are much used also in dyeing, calico-printing, and in making INK.

Apples of Sodom, which are brought by travellers as curiosities from the shores of the Dead Sea, are large galls full of dust and larvæ, or the grubs of insects.

The word gall is from the Latin *galla*, a gall nut.

GAMBOGE or **CAMBOGE,** the hardened juice of a tree that grows in Siam, Cochin China, and Ceylon. The juice is caught, when it runs from the tree, in cocoanut shells, and put into earthen vessels to thicken. Before it is hard it is poured into hollow joints of bamboo, where it hardens into round sticks. Sometimes it is made into lumps and cakes. The best gamboge is of an orange yellow when dry, but bright yellow when rubbed in water. It is used in medicine and as a paint.

The word gamboge, or camboge, is made from Cambodia, the name of the country from which it was first brought.

GARLIC, a kind of small ONION, with a strong flavor and rank smell, much used for seasoning food, es-

pecially in Spain, France, and Italy. The bulb is made up of several small bulbs, called cloves. The juice of garlic makes a strong cement for mending broken glass and china. It is used also as a medicine, mostly for rubbing on the skin in cases of fever and in nervous diseases in children. Wild garlic grows in pastures, and as it comes up early in the spring, cows eat it with the early grass, and their milk and butter often smell strongly of it.

The word garlic is from the Anglo-Saxon *gârleác*, which is from *gâr*, spear, and *leác*, leek, because the leaves stand up like spears.

GARNET, a dark red PRECIOUS STONE, somewhat like the ruby, but cheaper, called by the ancients carbuncle. When cut round and flat, like a drop of tallow, the garnet is still called carbuncle. There are also black, brown, green, and yellow garnets. The kinds most prized are the red and the black, which are often cut and set as jewels, or made into beads for necklaces. Some of the red ones when set in gold, look almost as well as rubies. The best garnets come from Ceylon, Peru, the Cape of Good Hope, and Greenland.

Very fine garnets are found in New Mexico and Arizona, where they are collected by the Indians from ant hills and scorpion nests. These stones, called there Arizona and New Mexico rubies, are very beautiful and can be cut into gems of two or three CARATS each.

The word garnet was once spelled *granate*, and is from the Latin *granatum*, a pomegranate, because the red garnet is like the seeds of that fruit in shape and color.

GAS. In the article ELEMENT is explained the difference between a solid, a fluid, and a gas. The common gas which we burn for light is made out of coal. You can make some very easily. Break a piece of bituminous or soft coal into bits, fill the bowl of a tobacco pipe with them, and cover the mouth over with moist clay and dry it. When well dried put the bowl into the fire where it will heat red-hot. In a short time a kind of yellow smoke will come out of the stem of the pipe, which will burn with a bright flame when lighted.

This smoke is coal gas, but it is not pure like that which we burn in our houses. If the end of the pipe stem be put under water, the gas will rise up through the water in bubbles. You can collect these bubbles of gas in a small bottle or other vessel in a very simple way. Fill the bottle full of water and turn it upside down in a bowl of water. The water will not run out of the bottle, because the pressure of the AIR on the water in the bowl will keep it in its place. If now the end of the pipe stem be put under the mouth of the bottle, the bubbles of gas will go up into it, and push the water down little by little; and if there be gas enough made in the pipe bowl, it will finally fill the bottle full, taking the place of the water. Thus you will have a bottle of gas, which will burn when lighted. All the coal gas used in cities and towns is made and collected in the same way, only the coal is heated in great brick or iron ovens instead of in tobacco pipes, and the gas is collected in immense iron gas-holders instead of in bottles.

If now you take off the clay from the pipe you will find some COKE in the bowl. This is some of the CARBON of the coal; a part of the carbon has gone off with all the HYDROGEN to make the gas, and this is all that is left. When we burn coal in the open air we get from it flame and ashes, but when we burn it in tight ovens, we thus get gas and coke. In making gas the coal is not really burned, but distilled (see ALCOHOL), and the gas passes off from the coal without making any flame. The ovens for distilling coal are called retorts. Several are

usually built up together, so that they may all be heated by one furnace, for there must be a fire outside the retort to heat the coal inside. When the retorts are filled with coal, the doors are closed tight and the coal inside is heated red-hot, when it gives off air, steam, tar, AMMONIA, and gas. All these pass off into a great pipe at the back of the retorts: the tar and ammonia run off into cisterns, and the hot gas goes into coolers, where it is cooled. It is next purified by passing over lime, which takes up all the ACIDS in it, and lastly is put into the gas-holders for use.

The gas-holders are the great round iron boxes, as large and as tall as houses, which are seen at all gas-works. Each one, which is open at the bottom, stands in an immense tank of water, and is so hung with weights, chains, and pulleys that it can easily rise as the gas collects in it. When full of gas, gas-holders stand up very high, but as their bottoms are all the time under water, none of the gas can leak out. Large gas mains or pipes lead from the gas-holders underground through the streets, and the great weight of the gas-holders pressing down on the gas in them keeps the pipes full and forces the gas through the smaller pipes into houses and stores. In each place where gas is used the gas passes from the pipe leading in from the street through a little box called a metre (Greek *metron*, measure), which not only measures it but keeps an account of it, so that the gas company can tell, by looking at the metre, just how much gas has been burned.

After passing through the metre the gas is carried though small pipes all though the building where it is used. These small pipes end in burners, where the gas is lighted. A burner is nothing more than a little opening in the end of the pipe to let the gas through, but as the gas will give more light if every bit of it be burned, various kinds of burners have been made, some with rows of little holes and some with little slits of different shapes, so that all of it will get to the oxygen of the air and none pass off as smoke. Thus we have fish-tail, fan-tail, swallow-tail, bat-wing and other burners. The Argand burner (see LAMP), so made that the gas comes out in a circle of little jets and has a glass chimney fitted to it, is one of the best, as it gives a very steady light.

Coal Tar. The tar which runs out of the coal in making gas was for a long time looked upon as almost worthless. It was used to paint iron fences, and other iron out of doors, to keep it from rusting, to mix with gravel to put on to roofs, and to mix with dirt to make side-walks. But after a time it was found out that many valuable things could be made from it, among which are naphtha, used for dissolving India-rubber and for mixing with different resins for making varnishes. From naphtha are made a kind of oil called benzole, used in lamps, other oils used for oiling machinery, for preserving wood from rotting, and for making dyes. From it are also got a good many acids, especially carbolic acid; the substance called aniline, from which the beautiful DYES called aniline colors are made; and paraffine, used in making candles. All these things are made by distilling (see ALCOHOL) coal tar in a close iron vessel. After the oils and other substances have passed off as steam, what is left in the vessel becomes solid on cooling, and forms a kind of pitch or ASPHALTUM, used in laying wooden pavements.

Natural Gas. The natural gas that comes from the earth, generally with petroleum, has long been known and used. In China gas rises from salt beds in the province of Szechuen and is carried through bamboo pipes and used both to light houses and to heat pans for boiling brine. At

Baku, on the shores of the Caspian Sea, the natural gas from the petroleum deposits has burned for centuries. In the United States natural gas was used in 1824 to light the hotel at Fredonia, N. Y., when General Lafayette visited that place. But, though known so long ago, it was not much used until the sinking of oil wells began in Pennsylvania. A good deal of gas always comes up with petroleum, and some of the wells give nothing but gas. Much gas was wasted at first, but now it is saved and carried in pipes to be used for fires and lights. Many towns and cities in Pennsylvania, New York, and Ohio are entirely heated and lighted by natural gas.

Natural gas is largely made up of HYDROGEN and marsh gas, which contains much CARBON. It is believed to come from the decomposition of animal and vegetable substances which ages ago were sunk deep in the earth. The gas rises and fills natural caverns or reservoirs, which are roofed over by rocks or solid clay strata so that it cannot escape upward, though it exerts an immense pressure. When a well is drilled through the rock or clay roof into the reservoir, the gas rushes up with great force. In 1878, a well at Murraysville, eighteen miles east from Pittsburg, had been sunk a quarter of a mile (1320 feet), when, without any warning, the derrick and other works at its mouth were blown into the air, and the gas rushed out with a noise that was heard five miles away. For several years the gas was wasted; then it was found out how it could be carried in pipes to Pittsburg. Other wells were sunk in the same neighborhood and later at Washington and Tarentum, southwest and northeast from Pittsburg, and now the city is mostly heated and lighted by the gas, even the factories and furnaces using it instead of coal; and Pittsburg, once a smoky, dirty city, is one of the cleanest in the country.

Gas wells have been sunk also in Ohio, West Virginia, New York, Kentucky, Tennessee, California, and other States.

The word gas was made by a physician named Van Helmont (Brussels, 1577-1644), and given to all substances like air. It is from the Dutch *geest*, German *geist*, meaning spirit.

GAUZE, a very light fabric of silk or linen, so thin that one can see through it. In weaving, gauze is something between plain weaving (see LOOM) and plain lace or bobbin net. An inferior kind of gauze is made of silk and cotton; and there is also a flannel called gauze flannel.

The word gauze was made from Gaza, a city of Palestine, whence it was first brought; the Spanish still call it *gasa*.

GAZELLE. See ANTELOPE.

GELATINE, an animal substance that melts easily in hot water, but which stiffens like a jelly in cooling. It is usually made from clippings of hides, hoofs, horns, and the feet of calves, cows, sheep, pigs, and other animals. These are carefully cleaned and boiled for a long time; the liquor is then strained and allowed to gelatinize or form a jelly. This jelly, which is called size, has a very bad smell, but it is sometimes purified with sulphurous acid and used for ISINGLASS. When not purified, it is cut into slices, dried, and sold as GLUE.

In the article BONE is told how by soaking a bone in weak acid all the hard part is eaten out and only the soft part is left. By boiling this soft part it will turn into size, which, when cool, becomes gelatine.

Gelatine is made up into beautiful sheets, some of which are clear like glass and some beautifully colored and stamped with ornamental designs. These sheets are used in France instead of glass for covering lanterns. Apothecaries make large use of gelatine for covering pills and

for making capsules to put bad tasting medicines in. A very pure kind of gelatine, prepared in France from bones, is much used by cooks, instead of isinglass, for making desserts.

The word gelatine is from the Latin *gelare*, to stiffen with cold.

GIMP, a kind of trimming used on dresses, curtains, and furniture. It is made of silk, wool, or cotton, with a fine wire or cord twisted among the threads to stiffen it.

The word gimp is in old French *guimpe*, *guimple*, a nun's wimple.

GIN, an alcoholic liquor, distilled from rye and barley and flavored with juniper berries. It was first made in Holland, whence it is often called hollands. It is also called sometimes Schiedam *schnapps*, because there are a great many gin distilleries at Schiedam. Pure gin is about half alcohol.

The word gin is shortened from geneva, which is from the French *genièvre*, JUNIPER. *Schnapps* is a Dutch and German word meaning a dram.

GINGER, a kind of spice made from the root of a plant that grew first in Asia, but is now raised largely

Ginger.

in the West Indies. The root, which is about as large round as a man's finger, is dug up when the stem withers, and scalded, dried, scraped, and washed. The young roots, preserved in sugar syrup, make a delicious sweetmeat, called candied ginger, which is sent to foreign countries from China, the East Indies, and the West Indies.

Ginger has much starch in it. Its strong taste is given to it by a light yellow oil, called oil of ginger. Essence of ginger is used as a medicine and by cooks for flavoring, and the spice itself, made by grinding the roots to powder, is used for making GINGERBREAD, ginger cakes, ginger beer, ginger pop, and ginger wine.

The word ginger was once spelled gingiber, and is from the Latin *zingiber*, ginger.

GINGERBREAD, a kind of cake flavored with ginger. It is made in several ways, in soft cakes one or two inches thick, in thin cakes called ginger-snaps, or in small buttonlike cakes called ginger-nuts. Gingerbread is often seen in bakers' windows made into figures of men, animals, and other things, and painted and gilded. In old times such figures were largely sold in country fairs in England, and from them ornamental work, cut or carved into strange forms, came to be called "gingerbread-work." The doum palm of Egypt is sometimes called the gingerbread tree, because its bark looks like gingerbread. Gingerbread is said to have been sold in Paris as early as the fourteenth century. In those days it was made of rye flour, kneaded with honey and ginger; but afterward, in England, wheat flour and molasses were used.

The word gingerbread is made up of GINGER and BREAD.

GINGHAM, a kind of colored cotton cloth first made in India. Its colors are woven in, instead of printed on, as in calico, the yarn being dyed. Some ginghams are of one color, like those used for covering umbrellas, and some of two or more colors woven in checks or stripes.

The word gingham is probably from the Javanese word *ginggang*, gingham.

GINSENG, the root of a common plant, much valued by the Chinese as a medicine. The plant, which grows about a foot high and bears yellow flowers and scarlet berries, is found from the Atlantic coast to the Rocky Mountains. It is said not to be genuine ginseng, but it belongs to the same family; and about 500,000 pounds of the roots are gathered and sent every year to China, where it sells for $2 to $4 a pound. It grows in abundance in forests back of the Catskill Mountains, where many men, women, and children go "ginsening," as they call it, every September. At Summit Station, Onondaga County, New York, is a ginseng farm, where it is cultivated.

The Chinese call ginseng "supernatural treasure for all desires," and believe it to be a sure cure for every disease. The best, raised in Manchuria, sells for its weight in gold, and is used mostly by the imperial family and great nobles. The government taxes it and gets a large revenue from it. Doctors here and in Europe say that ginseng has very little medicinal value, but the Chinese think that our opinion of it is only another proof of the want of common sense of the "foreign devils."

GIRAFFE. This beautiful animal is found wild only in Africa. The first one ever seen in Europe was shown by Julius Cæsar in the circus in Rome, and others were afterward exhibited there by other emperors; but after the fall of Rome, no live one was ever taken to Europe until 1827, when the Pacha of Egypt gave one to the French and one to the English. Many giraffes have since been brought from Africa and shown in menageries, both in Europe and this country, and now almost every child knows how one looks.

A full-grown giraffe is sixteen or seventeen feet high, or nearly three times as tall as a man. Its long neck enables it to eat from the tops of high trees, the leaves of which make a large part of its food. Its tongue is long and slender, and can be run far out to draw leaves and branches toward its mouth. Between its ears are two short horns, not like those of the ox, but only bones covered with a hairy skin. Its body is short, and is higher in front than behind, so that the backbone slants downward. Its legs are

Head of a Giraffe.

slender, and the feet have cloven hoofs, like those of an ox. The skin, which is of a light reddish orange marked with large spots of a darker color, is covered with short hair. The neck has a short mane, and the tail has a tuft of black hairs at its end. The giraffe's gait is very awkward, as it moves both the legs on one side at the same time, like a pacing horse, but it can run very fast, and only a swift horse can catch it.

Giraffes live usually in families of about a dozen, generally on the edge of deserts where they can see all round. Their chief enemies are the lion and the panther, from which they can run away in the open country; but when a giraffe is caught in woods by one of these beasts, it fights with its fore feet with such force that it sometimes kills or drives

it off, but is often killed itself. The Hottentots lie in wait for the giraffe near its watering-places, and shoot it with poisoned arrows. They eat its flesh, and make straps, cups, and leather bottles out of its thick skin. The Arabs are also very fond of giraffe meat, and they make shields of its hide, and thread and strings of its long sinews and tendons. Many giraffes are now hunted for menageries, but it is very seldom that a full-grown one is caught. They are usually chased when the young are sucklings. When a baby giraffe is caught, it will soon become very tame, if it can be made to eat; but often it will not take any kind of food, and dies in a few days. In menageries giraffes are fed on grain, Indian corn, carrots, and hay.

Sir Samuel Baker and other African travellers say that wild giraffes are far handsomer than those seen in menageries, the color of the skin changing its tints in different lights as the animal moves along. The eyes are larger and more beautiful than those of the gazelle (see ANTELOPE). The giraffe can see very far, and it has also a very strong scent, and can smell a man a great distance off if the wind happens to be blowing toward it. On this account hunters find it very hard to get near enough to one to shoot it, and can do so only by creeping up against the wind behind grass and bushes. Even then the giraffe often spies the hunter and runs away, because its neck is so tall that it can see over most bushes.

The giraffe is a MAMMAL of the order *ruminantia* or cud-chewing animals.

The word giraffe is in Spanish *girafa*, which is from the Arabic *zurafa*, meaning long-neck. The animal is sometimes called camelopard, from the Latin *camelus*, camel, and *pardalis*, panther, because it is like a camel in some things, and is spotted like a panther.

GLACIER. See ICE.

GLASS. The things out of which glass is made are among the most common in nature. One of the principal non-metallic ELEMENTS is SILICON, which is found almost everywhere mixed with OXYGEN, in which state it is called silicic acid or silica. It is really an ACID, although a very weak one, for when heated red-hot it will mix with ALKALIES or BASES to form SALTS, which are called silicates. Common glass is only a silicate of soda or of potash, that is, it is a mixture of silica with the alkalies or bases called SODA and POTASH. By mixing some other things with these all the different kinds of glass are made. Silica is found in its purest form in rock crystals, some of which are almost as clear and bright as diamonds; but all quartz, flint, sandstone, and sand are made of it. Formerly the silica for making glass was mostly got from flint, which was burned and ground to powder; hence the name flint glass. But now pure white quartz sand is generally used, the best in the world being found in Berkshire County, Massachusetts. Soda is easily made from salt, and potash is found in all ashes. Lime, which is also a very common mineral, is put into glass to harden it; and oxide (see OXYGEN) of lead to make it brilliant. Other oxides of metals are used to color glass: for instance, the oxide of iron gives it the green color seen in common bottle glass.

The different things used in making glass are carefully sifted and mixed together before melting. The mixture, which is a kind of coarse yellowish flour, called "frit" or "batch," is melted in large pots set into a furnace. The furnaces, which are usually in the centre of the glass-house, are built of fire-proof bricks, made out of clay and a CEMENT got by grinding up old pots or crucibles. The fire in the furnaces, in which coal is burned, is never put out until one is so worn that a new one has to be built, which is every year or

two. Each furnace holds eight or ten pots, which are so placed upon stands that the fire can get all round them; and opposite each pot is a door, called a working-hole, through which the workman can fill it with frit, or take the melted glass out of it. The pots are made of the same clay as the furnace, and are of several shapes, of which two kinds are shown in the picture, Fig. 1. The

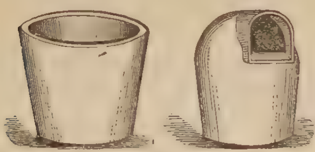


Fig. 1.—Crucibles.

one open at the top is used for melting common glass; and that covered over, with an opening in front, for those glasses in which lead and other metals are used, and which need less heat. Common glass, which is made of only sand, soda, and lime, needs much more heat, because the frit will not melt unless the flame of the furnace can reach it. When the pots are set into the furnaces they are not taken out until they are used up. They last generally from one to two months.

When all is ready, the frit, mixed with about one fourth its weight of broken flint glass, is thrown, with a clean iron shovel, into the pot through the furnace doors, which are then closed tight, and the fires are raised to a white heat, which melts little by little the contents of the pots into liquid glass ready for use. It usually takes twenty-four hours to melt a furnace full of glass-pots. When it is done the heat is allowed to go down until the glass becomes about as thick as paste, and it is kept in that state until it is all used up by the workmen, who labor day and night, six hours at a time. The principal tool used in working glass is the blowing-tube, an iron pipe about five feet long, one end of which is covered with wood, so that the person using it may not burn his hands while the other end is red-hot, wood being a non-conductor of HEAT. Besides this each workman has a solid iron rod called a "punty," a pair of shears, a pair of spring tongs, like sugar tongs, to pick up pieces of hot glass, and several calipers and other small tools to shape with. The glass maker's chair is a low wide bench with two arms, like those of a chair, on which he can roll his blowing-tube when he wishes to shape the hot glass at the end of it; and the marver (from French *marbre*, marble, because it was formerly made of marble) is a smooth cast-iron slab, on which he can roll the hot glass to make it round.

The method of blowing and of working will be best shown by telling how a wineglass is made. There are two ways of doing this, in one of which it is done entirely by the skill of the workman, while in the other he is aided by a mould or press. In the first process the workman takes out of the melting pot on the end of his blowing-tube glass enough for one wineglass, as shown in the picture, in *a*, Fig. 2. He then blows through his tube and makes a bubble of glass as in *b*, and after rolling it on the marver flattens its end with a wooden tool called a battledore, as in *c*. A lump of melted glass is stuck on the flat end, as in *d*, and the workman gives it the form, shown in *e*, by rolling his blowing-tube over the arms of his bench and shaping the hot glass with a kind of shear called "pucellas." A little globe of glass is now fastened to the end of this and opened with the points of a tool, as in *f*, which makes it flat, as in *g*. A little hot glass is then taken up on the punty, by which it is stuck to the bottom of the wineglass, as in *h*, and the other end, to which the blow-pipe is still fastened, is cut off across the dotted line. The top is then trimmed with

the shears, as in *i*, and the glass is finally finished, as in *j*. It is then knocked off from the punty and carried by a boy on a forked rod to an oven, where it is heated with many others and then allowed to cool slowly. This process, which is called annealing (from Anglo-Saxon *anælan*, to bake), tempers the glass, that is, makes it less brittle and less apt to break.

A common decanter is made in much the same way. A lump of glass is gathered on the end of the blowing-iron, as in *a*, Fig. 3. The workman blows it up a little and swings it round his head until it takes the shape *b*. More blowing and swinging make it larger and longer, when the end is flattened with the battledore, as in *c*. It is next made into the shape *d*, when it is stuck on to the punty at the flat end, and cracked off from the blowing-iron across the dotted line. The mouth is then heated in the furnace and shaped with tools. Another workman then takes some melted glass on the end of a punty and winds it round the neck to make a ring, as shown in *e*, and the first workman rolls the decanter round and round on the arms of his table and shapes each ring thus put on

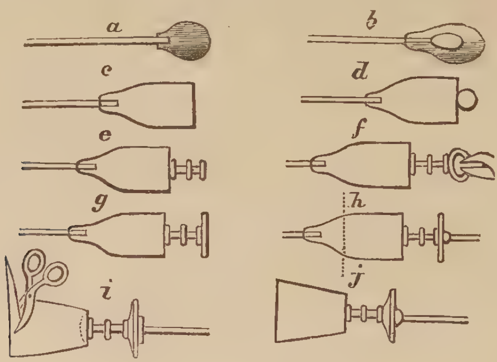


Fig. 2.—Making a Wine Glass.

with a tool. Lastly, the neck is softened again in the furnace and the mouth and lips are finished, as shown in *f*. Such a decanter is a plain one, but many decanters are ground and beautifully ornamented.

The second way of making drinking glasses and other small pieces of table ware is called pressing. The workman gathers a lump of glass on the end of his punty and drops it into a kind of mould shaped like the outside of the article to be made. A plunger, shaped like the inside of the article, is then pressed down into the hot glass, which is thus squeezed into the exact form wanted. A great many tumblers are made in this way. The little prisms, or three-cornered ornaments of glass which are often hung on chandeliers, are pressed between two brass dies, each of which makes one half the prism. One of the dies is fitted with little steel points which pierce the holes for the wires by which the prisms are fastened to each other.

Glass-Cutting. After wineglasses, goblets, tumblers, decanters, and other glassware have been annealed, they are often cut. Glass-cutting is really grinding. The glass to be cut is first ground by being held against a cast-iron wheel, which has a thin stream of sand and water dripping on it from a box above.

The sand wears away the glass, but leaves rough marks. These are first smoothed out on a stone wheel wet with water, then on a willow-wood wheel covered with PUMICE and rotten-stone, and finally polished on a wooden wheel with a soft powder called putty-powder, made of the rust (oxide) of tin and lead. Glass engraving is done by wearing down the glass on very small wheels of iron, copper, or lead, covered with emery or some other powder, and made to turn round very fast in a lathe. Some glass is engraved by means of the SAND blast.

Window Glass. The making of window glass is one of the most important of glass manufactures. There are three kinds of it, crown glass, cylinder or sheet glass, and plate glass. Crown and cylinder glass are both made by blowing, but in different ways. In making crown glass the workman collects a lump of glass on his blowing-tube, and blows it into a hollow ball, as shown in *a*, Fig. 4. A boy now takes some melted glass on the end of a punty, and sticks it to the bottom of the ball. The workman then breaks off his blowing-iron, and the hollow ball, held up on the punty, takes the form *b*. It is then carried to the mouth of a furnace where it is turned round while the heat softens the glass. As the glass gets softer it is turned faster, the opening at the top

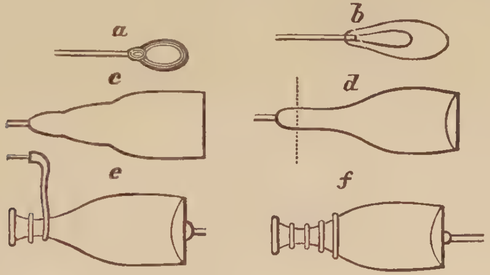


Fig. 3.—Making a Decanter.

slowly widens as in *c*, and the glass finally spreads out into a round flat plate, as in *d*. This plate, which is about five feet wide, is of equal thickness all over, excepting in the middle,

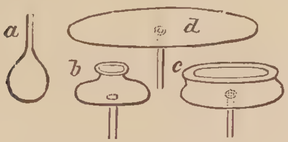


Fig. 4.—Making Crown Glass.

where it is fastened to the punty, where there is a swelling called the "bull's eye." As the plate is very soft it would fold together if the workman stopped turning it, so he keeps up the motion until it is cool enough to retain its shape. It is then sent to the annealing oven, and when annealed is cut up into window panes.

In making cylinder or sheet glass, the glass ball is blown up in the same way, and is then swung backward and forward, and finally entirely around over the workman's head, until it takes first the shape *a*, Fig. 5, and then the shape shown in *b*. It is next heated at the furnace until the end becomes soft. The workman then closes the end of his blowing-tube so that the air cannot get out, and the heat swells the air in the inside of the glass and bursts out the end, as shown in *c*. The soft edges of the opening are now worked

out until they are straight with the sides of the cylinder, as shown in *d*. The cylinder is next laid on a rest, the blowing-pipe is broken off, and the workman wraps around the end

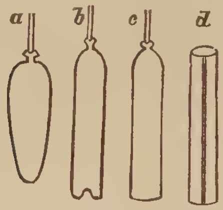


Fig. 5.—Making Cylinder Glass.

where the pipe was fastened to it a thread of melted glass. In a few seconds he takes this off, and on touching his cold shears to the hot line made by it, the end of the cylinder cracks off as neatly as if it had been cut by a diamond. The cylinder, which is now precisely like a common argand lamp chimney, only much larger, is then cut open with a diamond and spread out flat, after which it is annealed.

Plate Glass is made in a wholly different way. The glass is dipped out of the melting pots into smaller ones called cisterns, which are so made that they can be hoisted out by means of a CRANE, and their contents emptied upon the casting table. This is a large thick iron table, made perfectly level and smooth. The melted glass is poured quickly over the table, being kept from running off the sides by long strips of metal, which are just as high as the thickness of the glass to be made. A heavy copper roller, whose ends rest on the strips, is then rolled over the glass, which spreads it out to the same thickness on all parts of the table. If there is too much glass, some of it runs over the edge and falls into water. As soon as the plate is cool enough to be moved it is put into the annealing oven, where it stays five days. When the plates are taken from the oven they are examined to see if they are fit for large plates; if any are found with flaws in them, they are cut up into small plates. The plates are finally ground by rubbing two of them together, with sand and water, and are then polished bright with EMERY and water, and finally with FELT rubbers. The largest window panes used in stores, and the largest MIRRORS, are made in this way.

Colored Glass for windows is made either like crown glass or like cylinder glass. The colors are made by mixing oxides of metals (see OXYGEN) with the other materials: thus gold gives red tints, from rose color to ruby and purple; silver, yellow; copper in one form a ruby red, and in another emerald green; cobalt, rich blues; arsenic, pure white; iron, dull green, etc. Sometimes, when the colors are too deep to let the light through, the glass is made clear on one side and colored on the other. This is easily done. The workman first gathers some clear glass on his blowing-iron, rolls it into shape on the marver, then dips it into a pot of melted colored glass, and finally blows it up and makes it into crown or sheet glass in the usual way. When finished the pane has only a thin skin of the colored glass on one side. Flint glass bottles, toilet-sets, and other vessels of plain glass are often colored on the outside in this way, and then ornamented with beautiful patterns by cutting through the colored layer by grinding on wheels, so that the clear glass underneath shows through.

Stained Glass, seen mostly in church windows, is made by painting the surface of clear glass with various materials, chiefly the oxides of metals, mixed usually with oil of turpentine. The pictures are painted with brushes like oil paintings; the glass is then heated red-hot in a furnace until the colors become stained into it. By this means a complete picture can be made on one large pane of glass, which in old times was

made up of a great number of small pieces set in lead frames.

History of Glass. The Roman writer Pliny says that glass was first found out by some Phœnician sailors, whose ship was driven ashore at the mouth of the river Belus, in Syria. As the sea was very rough they cooked their dinner on the beach, and finding no stones to rest their pots on, they put under them some pieces of *nitrum* (supposed to be soda), with which their vessel was laden. This and the sand, melted by the heat of the fire, ran together and made glass, which the sailors were surprised to find among the ashes. As it would take a much stronger heat than could be got from an open fire to melt glass, this story is hardly to be believed. But there is no doubt that the Phœnicians knew how to make fine glass, which they cut, engraved, gilded, and stained of the most beautiful colors. They probably learned the art from the Egyptians, who made glass at least three thousand years before Christ. In some of the tombs near ancient Thebes, are still to be seen pictures of workmen blowing glass in the same way in which it is blown to-day. The Greeks knew how to make very beautiful glass, and a large number of ancient cups, bottles, vases, and urns, of many shapes and colors, found in tombs in the island of Cyprus by General di Cesnola, are now in the Metropolitan Museum of New York. The making of glass was not carried on in Rome until about the first century before Christ. Beautiful specimens of Roman glass have been found in Pompeii and Herculaneum, and it is known that many of the principal houses in those cities had glass windows. After Rome was destroyed by the barbarians, the art of fine glass-making was nearly lost, and only churches and public buildings had glass windows. For a long time the Venetians made the best glass in Europe, and it is probable that they first made glass mirrors. Three hundred years ago glass windows were so rare in houses in England that only castles and the houses of the rich had them, and the window frames were often taken out and packed away for safe keeping when the family were not at home.

The word glass is from the Anglo-Saxon *gläs*.

GLOVE, a covering for the hand, differing from the mitten in having a sheath for each finger. Gloves are made of worsted, cotton, silk, India-rubber, and different kinds of skins. Those made of threads are woven on machines; skin gloves are cut out and sewed together. The finest kid gloves are made from the skins of kids, but many of the cheaper kinds are made of lamb, rat, and other thin skins. The skins are first prepared and dyed with great care. The different pieces for the glove are cut out with punches, which make at the same time the little holes for the stiches along the edge of each. The two edges to be sewed together are then placed in the jaws of a VICE, having fine teeth like those of a comb, through which the needle is passed so as to make the stitches even. When sewn, the gloves are beaten in a damp linen cloth to soften them, and then pressed. Fine gloves of dogskin and other heavy skins are made in England; and good buckskin gloves and some kid ones are made in the United States.

Gloves have been worn by almost all nations from the most ancient times. In the Middle Ages they were a costly part of the dress both of men and women, and were often richly embroidered and ornamented with precious stones. It was customary for a knight who had won a lady's favor to wear her glove in his helmet, and in those times the throwing down of a glove was the common way of inviting a person to fight a duel.

The word glove is from the Anglo-Saxon *glof*. The Germans call a glove *handschuh*, hand-shoe.

GLUE, a coarse kind of GELATINE, used as a cement for sticking things together. It is made usually from the parings of hoofs and hides from tanners' and furriers' shops, and the clippings of hoofs, ears, and tails from slaughter-houses. These are cleansed by soaking in lime-water, and boiled in a large network bag until all the gelatine is out of them. The liquor is then drawn off and fined, or clarified, when it is cooled to a jelly, which, while still soft, is cut with a spade into square pieces. These are next cut with a brass wire into thin slices, which are dried in the open air and afterward by stove heat.

The contents of the bag are boiled a second and a third time to make size, a kind of thin glue used by painters, paper-hangers, and plasterers, and the scraps are then sold for manure.

The word glue is from the Latin *gluten*, glue or paste.

GLUTEN, a tough, sticky, glue-like substance, found in wheat and most other grains. If wheat flour dough be worked in a cloth in running water until the water is no longer whitened by it, that is, until all the STARCH is washed out, what is left in the cloth will be called gluten. It is this which gives firmness to bread; if wheat flour were all starch and had no gluten in it, bread made from it would crumble to pieces. It is this also which makes wheat bread light and more spongy than bread made of rye flour which has less gluten in it; the carbonic acid gas, which is formed when the yeast works in the dough, is caught in the gluten and swells it up in little bubbles, and these puff up the whole mass.

Gluten, like starch, contains CARBON, OXYGEN, and HYDROGEN, but it also has in it another ELEMENT, NITROGEN, which starch does not have. This is an important difference, and makes gluten very valuable as a FOOD. All the grains used for food have more or less gluten in them. Wheat, rye, oats, barley, and corn have a good deal in them, but rice has but little, and is therefore not so rich a food as the others. The bran of wheat and of most other grains has more gluten in it than the inside of the grain; hence when flour is bolted or sifted very fine and white, it is not so good for food as that made from the whole grain.

The word gluten is Latin, and means glue or paste.

GLYCERINE, a sweetish liquid, without color or smell, got from many fats and oils. Glycerine has many uses in the arts. In will keep meats, fruits, and flowers from decaying, and natural history specimens are often preserved in it. If a little of it be put into ink, the ink will stay damp for a long time so that a copy may be taken from it. As it does not freeze easily, it is added to the water in GAS meters. In medicine it is used to dissolve drugs in, and to put on the skin when scalded or burned. The Russians rub it on the face in cold weather to protect it from frost-bites. A little glycerine put into suds for blowing soap-bubbles will make the bubbles better and brighter.

Nitro-Glycerine, an explosive used in war, and for blasting in mines, tunnels, and quarries, is made of glycerine treated with nitric and sulphuric acid. It is an oily liquid, clear and colorless, or yellowish, without smell, and has a sweetish burning taste. When poured out in a thin layer, it will burn, but if heated in a closed space it will explode with a force about three times that of gunpowder. It can be used, too, in wet places when the use of gunpowder is impossible.

In 1885 a hundred and fifty tons (300,000 pounds) of nitro-glycerine compound were exploded at once under Flood Rock at Hell Gate, at the entrance to the East River, New York. Nitro-glycerine was discov-

ered in 1846 by Professor Ascanio Sobrero, of Turin.

Dynamite is nitro-glycerine mixed with some absorbent (dryer), such as sawdust, or a kind of earth called kieselguhr, found at Oberlohe in Hanover, Germany. It was first made in 1866 by the Swedish chemist, Alfred Nobel, who mixed one-fourth of the earth with three-fourths of nitro-glycerine. It is a soft putty-like material, varying from light yellow to yellowish red. Dynamite is safer to handle than nitro-glycerine. It is used in blasting, and in war for charging shells for the dynamite gun (see CANNON). Carbo-dynamite is nitro-glycerine mixed with carbon. It is much like dynamite, but is not affected by water, while common dynamite will dissolve in it.

Nitro-gelatine, or blasting gelatine, is nitro-glycerine gelatinized by mixing with gun-cotton. Camphor is generally added to make it less liable to explode from a blow or friction. It is much used in war for military mines, when it is fired by electricity, and in blasting. It was much used in making the St. Gothard Tunnel. It also was discovered by Nobel in 1875.

The word glycerine is made from the Greek *glukus*, sweet.

GNEISS. See GRANITE.

GNU. See ANTELOPE.

GOAT. The goat is like the sheep in many things, but is stronger, spryer, and less timid. It has a beard, too, which is wanting in the sheep, and its horns are usually longer and straighter than those of the sheep. Goats are very useful to mankind. Their flesh is good, that of young kids being considered a great delicacy, and their milk is very rich, and easier to digest than that of the cow. For this reason it is often drunk by invalids, and is given to babies, especially in Ireland, where babies sometimes take it directly from the goat. Good butter and cheese are made from it in some countries. Goats give generally about two quarts of milk a day, but some give three or four.

The skins of kids are made into kid GLOVES, and the skins of goats furnish the best MOROCCO. The hair of the goat is made into a great number of articles, among the most valuable of which are CASHMERE shawls. From the hair of white goats are made the large wigs worn by judges in England. Goats' horns are made into knife handles, and the fat of goats makes excellent candles. Goats are also much used for drawing children's carriages, and may easily be trained to mind the rein.

Goats are found all over the world, in all climates. Among the most valuable kinds are the Cashmere

Cashmere Goat.

goat of Thibet, which has long, straight, fine hair; the Angora goat of Asia Minor, whose hair is also fine and silky, but is curly and shorter than that of the Cashmere goat; and the Syrian goat. The Rocky Mountain goat is an ANTELOPE.

The goat is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word goat is from the Anglo-Saxon *gat*, goat.

GOLD, a METAL, one of the ELEMENTS. Gold is not only one of the most precious, but is also one of the most beautiful and most useful of the metals. It is the only yellow metal, and is the most lasting, the most easily worked, the most malleable or easy to be hammered out, and the most ductile or easy to be drawn out, of all the metals. It

is also one of the few metals found pure.

Gold is found almost everywhere, but is not plentiful enough in all places to pay for the labor of getting it. Sea water has gold in it, and it is said that there is more in the waters of the ocean than has yet been taken out of the earth. Gold is found in many kinds of rocks, but chiefly in QUARTZ. By the crumbling away of rocks by frost and rain, grains of gold are washed down into the valleys and river beds; and thus have been found the rich deposits called placers in the gravel and sands of streams. Gold in placers comes in dust, scales, grains, and lumps, some worn round, and others bearing the marks of the rocks in which they were once bedded. As gold is heavier than sand and gravel, it usually works its way down until it reaches the rock underneath it, where it settles in the holes in its surface, called pockets. In placer mining, the top soil is usually dug away, down to the rock, where the largest lumps of gold are found in the pockets; but all the upper soil is carefully washed and searched so that even the little scales and grains may be saved. Large lumps are called nuggets (from an old word *nigot*, changed from ingot). They are sometimes found as large as a man's head, and one dug in Australia weighed 233 pounds.

The gold found in rocks is usually smaller than that dug from placers, and it takes much more labor to get it out. The rock must first be blasted out, and if it is underground has to be raised to the surface. It must then be crushed to powder in a stamping mill, and thoroughly washed with water. The washing is done in different ways, but generally by means of a series of sieves to separate the larger from the smaller particles, and of a slanting table over which a stream of water flows. The quartz grain and other earthy matter are washed away, and the gold grains, which are heavier, remain at the head of the table. When the gold dust is very fine, it is separated by a process called amalgamation. An AMALGAM is made by mixing the fine dust with MERCURY, or quicksilver, which has the power of seizing upon all the little grains of gold and uniting with them. The mercury is afterward separated from the gold, which is thus got pure.

Gold is found in Europe chiefly in Hungary and Transylvania, where it is washed from the sands of rivers; in Asia mostly in Siberia, in the Ural and Altai Mountains, where it is found in sand and gravel and in rocks; and in Africa in Abyssinia, on the Gold Coast, and from the sands of several rivers. In America, Brazil was formerly the richest in gold, but the mines of the United States are now the most valuable in the world. California and Montana furnish the most gold, but much is also mined in many of the other States and Territories. Next to the United States, Australia gives the most gold.

Gold when pure is nearly as soft as lead, and is therefore unfit to be used either for coin or for jewelry until it has been hardened by mixing it with some other metal. (See ALLOY). Copper is mostly used for this, because it does not change the color much, except to make it a little redder. In the United States and France gold coins are made of nine parts of gold and one part of copper, and in Great Britain of eleven parts of gold and one of copper. The red gold of jewellers is made up of three parts of gold and one part of copper. By mixing gold with silver, jewellers lighten the color of gold, and give it a greenish shade, and by mixing it with iron give it a bluish shade. The alloys of gold with copper and silver are not only harder than pure gold, and thus wear better, but they will also melt easier.

Jewellers mark the fineness or the purity of any alloy of gold by supposing it to be divided into twenty-four equal parts called carats, its fineness being according to the number of parts of pure gold in these twenty-four parts. For instance, gold 18 carats fine has in it eighteen parts of pure gold and six parts of other metal. Jewellers commonly spell this word *karat*, and mark gold with a K and the figures marking the number of carats. Thus gold of 18 carats is usually marked K 18.

Gold may be hammered out into leaves so thin that 200,000 of them piled up will not be more than an inch high (see GOLD-LEAF); and a single grain of it may be drawn out into a wire 500 feet long. On this account gold is one of the most useful metals employed in the arts, for articles covered with a thin coating of it are as beautiful as pure gold itself. Other metals, stone, porcelain, glass, wood, ivory, silk, paper, and many other substances, may easily be gilded in different ways. (See BOOK, BUTTON, METAL-WORK, POTTERY.)

Gold will not mix directly with OXYGEN, that is, it will not rust; it is therefore one of the most lasting of all the metals. It is not eaten by any of the common acids, but is easily dissolved by a mixture called *aqua regia* (royal water, because it dissolves the king of metals), made of one part of nitric acid and four parts af hydrochloric or muriatic ACID.

The word gold is Anglo-Saxon.

GOLDENROD, the name of a family of plants with spires of golden yellow flowers, seen along the sides of roads, hills, and gravelly banks in autumn. There are about eighty kinds, of which all but three or four belong in North America, for which reason, as well as on account of its beauty, it has been proposed as our national flower. The goldenrod is found along the margin of the sea, on the western prairies, and high up on northern mountains. It generally likes dry and sandy soils, but some kinds grow well in bogs and other wet places. Almost all the kinds have golden yellow flowers, though a few are of a lighter yellow, and one kind is white.

GOLDFISH. This fish, sometimes called golden carp, was first brought from China, but it is now common in Europe and the United States. When full grown it is bright orange above, lighter on the sides and whitish below; but when young its color is dark, and when old it fades to a silvery white. In China goldfish are kept as pets in almost every house, either in open porcelain vessels or in little ponds. In this country many are kept in glass globes, but these are very poor dwellings for them. Fish need a great deal of air, and but little can get to the water in a globe. They also need shade sometimes, and when in a glass globe they are always in a blaze of light. The water in a globe, too, must be changed often, else the fish will not be healthy, and as they have to be lifted out, when this is done, either by hand or with a small net, they are apt to be injured. But if you wish to keep them in a globe, get one with as wide a mouth as possible, and do not fill it more than three-fourths full of water, so that enough air can get to it. Keep it in the most airy part of the room, and never set it in the sun or near the fire. Never feed the fish, as they will get enough food from the ANIMALCULES in the water, which must be changed every day. Do not give them any bread; goldfish are often killed by being fed with bread, which sours in the water and makes it unfit for them to live in.

It is far better to keep goldfish in the basins of fountains or in small ponds, where they will have plenty of room. They will become very tame, and may be taught to come to the surface at the sound of a bell. When protected from other fish,

which eat both their spawn or eggs and their young, they will increase very fast. They are found now in the Hudson and other rivers, and in many lakes and ponds in New York and New England.

The goldfish belongs to the same family with the SUCKER and the CARP. It gets its name from its color.

GOLD-LACE, lace or braids made by weaving gilded silken threads. To make the threads, a silver rod is gilded with GOLD-LEAF by laying the leaf on it and rubbing it until it is all covered. The rod is then drawn into WIRE so fine that one ounce of it is more than a mile long. It is then flattened between steel rollers. The film of gold on the silver is much thinner than gold leaf, but covers the silver so perfectly that it looks like gold. This fine flat wire is now twisted by means of a small machine around threads of yellow silk made for the purpose, so that when finished they look like gold threads; and out of this gilded silk are made gold lace, gold braid, epaulets, etc.

The word gold is Anglo-Saxon. Lace is from the Latin *laqueus*, a net.

GOLD-LEAF, gold hammered into a thin leaf to be used for gilding. The process is called gold-beating, and the workman who does it a gold-beater. The gold used is either pure or mixed with various parts of copper or silver, according to the color, of which there are a dozen different shades. The metal is first melted and cast into flat oblong pieces called ingots. The ingot is then flattened out by rolling between steel rollers until it is so thin that it would take 800 of them piled up to make an inch in height. This is next cut up into pieces an inch square, and 150 of these are piled together with a small sheet of parchment, or a kind of paper made for the purpose, between each, and put into a parchment case. The gold-beater now hammers this with a heavy hammer until the inch pieces are spread out into pieces four inches square. Each of these is then cut again into four parts, so as to make 600 pieces, each two inches square, and all are again packed up, this time with gold-beater's skin between the leaves. Gold-beater's skin is made of the large intestine or gut of the ox, and is prepared with great care. The pile is beaten as before, but with a lighter hammer, and is then cut again, making the 600 pieces into 2400 pieces. These are separated into three packets of 800 each, and again beaten between leaves of gold-beater's skin for four hours with a still lighter hammer, when each leaf is spread out so thin that it would take more than 200,000 of them piled up to make an inch in height. The leaves are then cut square and put between the leaves of little books, twenty-five in each book, the paper of which has been rubbed with red chalk to keep the gold from sticking to it, and are ready for use. Silver and copper leaf are made in nearly the same way, but they are both a little thicker than gold leaf, because those metals are not so malleable (Latin *malleus*, a hammer) as gold. As pure silver leaf would be apt to turn black in the air, it is always made of part gold and part silver. Gold beaten out but once between leaves of parchment is called dentist's gold, and is used for stopping teeth.

Wood, plaster, papier-maché, and many other substances may be gilded by covering them with gold leaf stuck on with a kind of sizing or glue. The gold leaf is not put on the wood, plaster, etc., itself, but on a mixture of whiting and glue called size. In gilding picture-frames for example, the wood is painted with four or five coats of size put on hot. This is carefully smoothed, when dry, with pumice stone and fine sand-paper, and another size, made

of clay, red chalk, black lead, suet, etc., is then put on. This, which is called gold size, is the groundwork for the gold leaf. The leaf is laid on with great care, so as to cover the whole surface, pressed with cotton wool into all the parts, and afterward smoothed with a brush. When dry, the gilding, or any part of it, may be burnished or polished bright by rubbing it with smooth agates set in handles for the purpose. The parts to be left dull are not burnished. In gilding on metals or surfaces to be much in the open air an oil size is used. (See BOOK.)

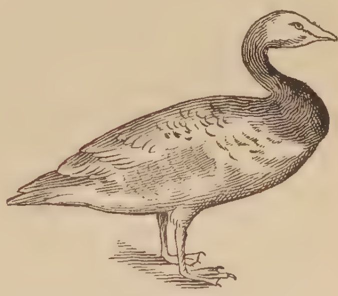
The words gold and leaf are Anglo-Saxon.

GONDOLA, a long narrow boat, with high prow and stern, much used on the canals of Venice, where it supplies the place of a carriage. Gondolas are twenty-five to thirty feet long, about five feet wide in the middle, where is a small cabin for passengers, and sharp at both ends. The bow is generally ornamented with a high iron plate, shaped somewhat like the letter S, with teeth cut in it. The gondoliers stand at the bow and the stern, if there are two; if there is but one he stands at the stern. In former times the nobles of Venice spent such immense sums in decorating their gondolas that the government passed a law that they should all be alike, and all have since been painted black. Some gondolas may be seen in the lakes of Central Park, New York.

The word *gondola* is Italian, a diminutive form of *gonda*, gondola.

GOOSE. There are several kinds of wild geese in the United States, but the most common one is the Canada goose. These geese spend the summer in the cool parts of British America, and the winter in the Southern States and South America. They may often be seen flying high, in regular order, going northward in March and April, and southward in September, and crying *honk! honk!* They usually come down to feed at night. Wild geese are of a dull gray, with head, neck, bill, tail, legs, and feet black. Their flesh and eggs are excellent for food, their feathers are valuable for beds, and their quills for pens. They are easily tamed and are often kept with domestic geese.

The **Barnacle Goose,** common in northern Europe, is so called because it was believed in old times that it came from a kind of shell-fish called the BARNACLE. In the North of England this goose was called brant



Barnacle Goose.

goose, that is, burnt goose, from its dark color; and in Lincolnshire, tree goose, because the barnacles from which they were believed to come grew on trees. These silly stories were believed less than three hundred years ago.

The **Common Goose** kept on farms is supposed to have sprung from the wild goose of Europe, which is a gray bird with a yellow bill. The ganders among tame geese are usually white, and the females gray. Before steel PENS were made, geese were largely raised in England and in Germany for their quills, which were plucked several times a year; and many are still raised for their feathers and for eating. By shutting geese up in cages so that they cannot move, keeping them very warm, and feeding them on fattening food, they soon become loaded with fat, and their livers greatly enlarged. From these

fat livers, which are really diseased, are made the famous Strasburg pies, or *pâtés de foie gras* (French, patties of fat liver), which are made in Germany and France and sent all over the world. The gizzards, heads, and legs of geese are called giblets, and are sold in sets for pies.

We often hear people say, "As silly as a goose," but the goose is by no means a silly bird, not nearly so silly as the OSTRICH. Geese are very sensible birds, and when treated well they behave as well as any other fowls. They tell a story in Germany of a gander that used to lead a poor blind woman to church every Sunday. It would take hold of her gown with its bill and lead her across the fields and through the village, and when it saw her safely seated would go into the churchyard and feed until service was over, when it would lead her back home again. That certainly was not a silly goose.

The goose belongs to the order *natatores*, or swimming BIRDS, and to the duck family.

The word goose is from the Anglo-Saxon *gôs*, goose.

GOOSEBERRY. There are several wild kinds of gooseberry in the United States. The common wild gooseberry has large berries covered with prickles. It is found in northern parts of the country, from the Atlantic to the Rocky Mountains. The swamp gooseberry, which bears dark purple sourish fruit, is common in New England and New York. The gooseberries sold in market are cultivated kinds called seedlings, because they were first raised from the seed of wild ones. They are almost always sold green.

The gooseberry was not know to the Greeks and Romans. It has been cultivated in Germany, Holland, and England since the sixteenth century.

The word gooseberry is from gossberry or gorseberry, and the plant is so named because it has prickles like the shrub called goss or gorse.

GOPHER, name given to different animals in different parts of the United States. In Illinois and several other Western States the PRAIRIE SQUIRREL is called the gopher; and in Georgia, Alabama, and other Southern States the name is given to a kind of TORTOISE. The true gopher, found in States east of the Rocky Mountains, differs from both of these; it is a burrowing animal, 8 to 10 inches long, reddish-brown above and ashy-brown below, with white feet. It has very strong claws for digging and long sharp teeth fitted for gnawing. On each side of its head is a large cheek pouch, in which it carries to its hole grasses, roots, nuts, etc., on which it feeds. The gopher does much harm to the roots of trees, shrubs, grasses, and vegetables, and is a great pest to the farmer.

The **Southern Gopher,** commonly called salamander, is found in Alabama, Georgia, and Florida. It is a little larger than the pouched gopher.

The **California Gopher,** of the Pacific coast, is very destructive to crops, and is caught in traps, and poisoned by farmers.

The gopher belongs to the order *rodentia*, or gnawing animals.

GORILLA. See APE.

GOUGE. See CHISEL.

GOURD, a family of plants to which belong the PUMPKIN, SQUASH, CUCUMBER, MELON, and others. The common or bottle gourd, sometimes called the calabash gourd, which grows wild in Asia and Africa, bears a fruit shaped like a water bottle, the rind of which is very hard when dry. These gourds make good bottles, dippers, funnels, and small dishes.

The word gourd is from the French *gourde*, a swelling.

GRAFT, a small shoot of a plant or tree made to grow in another plant or tree, so that the two unite and become one. The shoot is

called a graft or scion, the plant in which it is set a stock, and the process grafting. Grafting is one of the most important parts of the fruit-grower's business. When the seeds of a valuable kind of fruit are planted, it is but seldom that the plants raised from them bear as good fruit as the parent; almost all are poorer, but sometimes it happens that one is better. When this occurs, the fruit-grower naturally wishes to get as many trees of the kind as possible. This he does by cutting off shoots from the new one and grafting them into the trunks or branches of other trees of the same kind which bear poorer fruit. The graft thus set on to another trunk will soon grow to it and spread out into branches, and will bear the same kind of fruit as the tree from which it was cut. Ornamental shrubs and many kinds of flowering plants may also be grafted.

Fig. 1.—Cleft Grafting.

There are several kinds of grafting. In cleft crafting the graft is sharpened like a wedge and set into a split in the stock, so that its bark joins that of the stock, as shown in

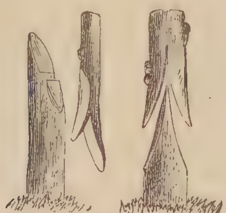


Fig. 2.—Tongue Grafting.

the picture, Fig. 1. In whip, tongue, or splice grafting the parts are cut so as to fit together in different ways, as shown in Fig. 2. Another kind of grafting is called budding. In this the bark of the stock is cut across with a knife and then slit downward from this cut, as in Fig. 3, so that the bark can be raised up. A bud of the present year's growth is then cut out of the tree to be grafted and is set under the bark of the stock, just as if it had grown there. In all kinds of grafting the parts cut are usually covered over with graftingwax or something else, and wound with a bandage to keep out the air and wet until the parts grow together.

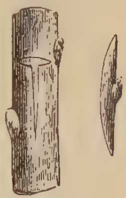


Fig. 3.—Budding.

The word graft is from the old English *graff*, which is from the old French *grafe*, Latin *graphium*, Greek *grapheion*, a pencil, because a graft is sharpened like a pencil.

GRAMPUS, a sea mammal of the dolphin family, called also cow-fish, and sometimes killer, because it is believed to attack and kill the whale. It is generally 15 or 20 feet long and is slate colored, its sides variegated with white marks, thought to be caused by scratches made by the animals teeth in playing with each other. It is found sometimes on our Atlantic coast, usually in large schools. Its oil, particularly that of its jaws, is highly prized.

The **California Grampus,** sometimes called the whiteheaded grampus, is often seen playing in schools on the Pacific coast.

The grampus is a MAMMAL of the order *cetacea*.

The word grampus is from the Spanish *grand pez*, from the Latin *grandis*, great, and *piscis*, fish.

GRANITE, a kind of rock made up of grains of FELDSPAR and QUARTZ, with sometimes MICA in it. When it has HORNBLENDE in it instead of mica, it is called syenite (from Syene, in Upper Egypt, where it was quarried in ancient times). When feldspar, quartz, and mica are so mixed that the stone will split easily into coarse

slabs or flags, it is called gneiss. When such stone has hornblende in it instead of mica, it is called syenitic gneiss. Granite is usually gray, grayish-white, or flesh color; syenite is red, or red mottled with dark green or black by the hornblende.

Granite is prized for its hardness, strength, and power of resisting the weather. It is, therefore, a very valuable stone and is much used in public buildings, in making docks, paving streets, etc.

The word granite is from the Latin *granum*, grain, and the stone is so called because it is made up of grains.

GRAPE, the fruit of the vine. Grapes grow in mild climates all over the world. In America there are four wild kinds: the northern fox grape, the southern fox grape or muscadine, the summer grape, and the frost grape. The different cultivated grapes in the United States, such as the Isabella, Catawba, etc., are supposed to have mostly come from some of these four kinds; but a few kinds have been made by grafting foreign grapes on American stocks. (See GRAFT.)

In all American grapes the soft pulp will easily slip out of the skin, but grapes that grow in Europe may be broken open right through the pulp, so that the seeds can be picked out. In this country foreign grapes are raised in cold graperies covered with glass, or in hot-houses, but only the home kinds are usually grown in the open air. In California, however, the foreign kinds do well out of doors. Grapes are raised chiefly for making WINE, although many kinds are used for eating and for making RAISINS.

The principal wine-making countries in Europe are France, Italy, Spain, Portugal, and Germany, where large tracts of land are covered with vineyards. In France and along the Rhine the vines are cut down into small bushes and tied up to stakes, but in Italy they are trained over elm and poplar trees and are allowed to run from branch to branch. Many grapes are also raised for wine-making in the Madeira, Azores, and Canary Islands, and some at the Cape of Good Hope, The grapes raised in Greece, the Ionian Islands, and Asia Minor are mostly made into raisins.

A great many kinds of grapes are now raised in the United States, both for table use and for raisin- and wine-making.

The word grape is in French *grappe*, and in Italian *grappo*. Vine is from the Latin *vitis*, grape-vine.

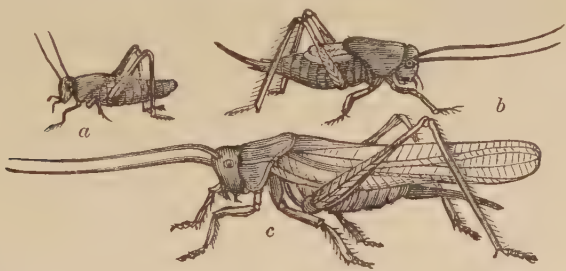
GRASS, a large family of plants, including, besides the kinds used for making hay, WHEAT, BARLEY, RYE, OATS, Indian CORN, RICE, SUGAR-cane, BAMBOO, and many reeds and canes. Although some of these are very small, and some, like the bamboos, grow as high as great trees, they are all alike in having jointed stems, sometimes solid, but usually hollow, and closed at the joints. The uses of the various grasses are very numerous and important. Among the things which we get from them are FLOUR, MEAL, STARCH, and GLUTEN; sugar and molasses, BEER, WHISKEY, RUM, and other liquors; PAPER and pasteboard, and all the many other things which are made from the different kinds of STRAW.

What is commonly called grass includes only the kinds which furnish herbage for cattle and horses, and which are made into hay. Clover is not a grass, although farmers sometimes call it so. Of the grasses used for hay, the most valuable are timothy, called herd's grass in New York and New England; red top, called herd's grass in the States south of New York; orchard grass, and Kentucky blue grass, called also June grass. Some kinds of grasses are raised for ornament, on account of the beauty of their leaves and flowers. Striped leaved grasses look very pretty in gardens, and

some dried grasses make beautiful bouquets.

The word grass is from the Anglo-Saxon *gräs*.

GRASSHOPPER. Most grasshoppers are green, much like the leaves and grasses on which they feed. They do not live together and travel in great swarms as the locusts do, but stay mostly in one place, and they are more active by night than by day. Their hinder legs are so long that they cannot walk, but move by leaps or hops. Their wings are quite large, but they make only short flights. The males make a shrill sound with their wings. The females have a sharp piercer at the end of the body, with which they make holes in the ground to lay their eggs in. The eggs, which are numerous, are covered with a shiny film or skin. They lie in the earth all winter, and are not hatched until spring. When the young grasshopper comes out it has no wings, so that it can only hop about by means of its long hind legs. But soon after it has shed its skin several times, its wings begin to grow. After it has reached its growth, it flies around as a perfect grasshopper for only about a month, and then shrivels up and dies. In the picture, *a* shows the young grasshopper in his first state of being; *b*, when his wings begin to grow; and *c* the full-grown grasshopper. Grasshoppers would be very harmful to vegetation if they were not kept down by birds, turkeys, and other common fowls, mud wasps, and others insects, to whom they furnish much food. The insects called grasshoppers in the West, which do so much damage by eating up the crops, are not grasshoppers but LOCUSTS.



Changes of the Grasshopper.
a, Larva; *b*, Pupa; *c*, Perfect Insect.

Katydids are a kind of grasshopper which live mostly on trees and shrubs. They lay their eggs in two rows of eight or nine each, on the twigs of trees, scraping off the bark and fastening them on with a kind of gum. Only the male katydid makes the sound which gives these insects their name, with its wings; the female makes no noise. The katydid makes a pretty pet for the few weeks of its life. It should be fed on fruit. The Indians of the West, where these insects abound, call them "grasshopper birds"; they roast and grind them into flour and make cakes of them.

The grasshopper belongs to the order *neuroptera*, .or nerve-winged INSECTS.

The word grasshopper is made up of grass, Anglo-Saxon *gräs*, and hop, Anglo-Saxon *hoppan*.

GRAVEL, small stones or pebbles, often intermixed with sand. It lies usually in deep beds under the soil, and in the beds and banks of rivers, but sometimes forms large hills.

Gravel is made by the breaking and wearing down of larger ROCKS, mostly by the action of water. It is much used for ballasting railway tracks, that is, filling in the spaces between the ties; for covering walks; and for making concrete and artificial stone,

The word gravel is from the old French *gravele*, gravel.

GRINDSTONE, a round, flat stone used for grinding or sharpening tools. They are made mostly of sandstone, are of different width and thickness, and are made to turn round, some very fast and some slowly, according to the work to be done. In mills they are turned usually by steam or water power. Steel goods, such as knives, forks, scissors, needles, razors, etc., are first forged into shape and then ground smooth on grindstones. Most of the grinding is done on dry stones, and the fine steel dust which rises makes the business of the grinder very unheathful. Coarse steel goods are ground on stones wet with water. Glass lenses for spy-glasses, opera-glasses, and telescopes are also ground down on stones.

The word grindstone is made up of grind, from Anglo-Saxon *grindan*, and stone, from Anglo-Saxon *stân*.

GROUSE. Among the birds rightly called grouse are the pheasant-tailed grouse or cock of the plains, the pinnated grouse, commonly called the prairie hen or chicken, and the ruffed grouse, called partridge in New England and pheasant in the Middle States. The cock of the plains is found only in the far West. It is the largest of the American grouse, being often as large as a turkey.

The **Prairie Hen** was once common in New York and other Atlantic States, but is now seldom found anywhere but in the prairies of the West. It lives on berries, grains, acorns, etc., and is much prized for food. Great numbers of them are shot or taken in nets and traps every autumn and sent to the Eastern markets.

The **Ruffed Grouse,** or partridge, is found in Canada and most of the Northern States. It lives usually in thick woods and is seen generally in pairs. The males make a kind of drumming sound by beating the air with their wings. The females lay nine to fifteen brownish-white eggs, usually in May. When partridges fly their wings make a loud whirring noise. In the autumn they live largely on partridge berries, which give their flesh a fine flavor, and they are therefore much hunted in that season.

The grouse belongs to the order *rasores*, or scratching BIRDS.

The word grouse is probably from the old French *griesche*, a moor hen.

GUAVA, the fruit of a small tree which grew first in Mexico, Central and South America. The tree, which is now cultivated in China, the Malay Archipelago, and Algeria, and other warm countries, is generally nine to fifteen feet high. It bears a bright yellow fruit, about an inch in diameter, which has a reddish seedy pulp, very pleasant to the smell and with a sweetish-acid taste. The fruit is much eaten in the West Indies, and large quantities of it are made into guava jelly and marmalade, and sent to foreign countries.

The word guava is from *guiava*, the Indian name of the tree.

GUINEA-FOWL. This bird gets its name from Guinea, Africa, from whence the first of these fowls were brought. It is sometimes called Guinea hen, and sometimes pintado (Spanish, painted). In Africa, in which country only they are found wild, they live in large flocks in woods along the banks of rivers, where they feed on seeds, grains, and insects. The common guinea-fowl is about as large as the domestic fowl, and is usually slate-colored or dark gray, covered with round white spots. The cock and hen are so much alike that it is hard to tell

them apart. Guinea-fowls are noisy and quarrelsome, will fight other kinds of fowls, and are apt to injure tender buds and flowers, so they are not very pleasant to keep as pets. They lay yellowish-white eggs, a little smaller than common hens' eggs, and covered with brown specks. They do not like to sit, and they make poor mothers, so it is best to hatch their eggs under common hens. The chicks, which come out of the shell in three weeks, are very tender, and a whole brood will often die during a cold storm. The flesh of guinea-fowls is of fine flavor, and their eggs are very good.

The guinea-fowl belongs to the order *rasores*, or scratching BIRDS, and to the pheasant family, in which are also common fowls, turkeys, and peacocks.

GUINEA-PIG. This little animal is found only in South America. Its common name, Guinea, is probably a mistake for Guiana, in South America, and it is called a pig because it grunts somewhat like one. It looks more like a rabbit than a pig. Guinea-pigs have short glossy fur, usually dark brown with black, white, and yellow patches. The most valued ones are marked like tortoise-shell. They are very pretty, gentle little animals, and are much kept as pets. Their food is wholly vegetable. They will eat whatever rabbits eat, but they like parsley and carrot tops best of all, and are very fond of tea leaves and of fruits. Though cleanly, they have a bad smell about them.

The guinea-pig is a MAMMAL of the order *rodentia*, or gnawing animals.

GUITAR, a stringed musical instrument, used chiefly to accompany the voice in singing. The cithara, which was somewhat like the guitar, was used by the Egyptians at least 1500 B. C. The modern guitar has six strings, the three highest of which are of CATGUT, and the three lowest of silk covered with silver wire. It has always been much used in giving serenades, especially by the Spanish.

The word guitar is from the Spanish *guitarra*, Latin *cithara*, Greek *kithára*, a cithara.

GULL, the name of a family of birds in which are several kinds called gull, the stormy petrel, the albatross, and others. The herring or silvery gull, which is white, is seen all along the Atlantic coast. It feeds chiefly on herring. The black-backed gull is larger, and has slate-colored back and wings, white breast, and yellow legs. It breeds in Labrador but goes as far south as Florida in winter. Gulls get their food near the surface of the water; they are not very good divers, but are good swimmers and strong flyers, and are often seen far out at sea. They live on small fish, shell-fish, young birds, eggs, and floating carrion. A gull will sometimes carry a shell-fish high up in the air and let it fall on a rock to break it.

The **Albatross** is the largest of the gull family and the largest of web-footed birds. It sometimes weighs twenty pounds, and measures across its spread wings twelve to fifteen feet, or more than twice the length of a man. Its home is in the southern seas, especially around the Cape of Good Hope, where sailors call it the Cape sheep, and it is often seen far away from land in the middle of the ocean. It lives mostly on fish, which it swallows whole, and it is so greedy that it is sometimes seen with a part of its food hanging out of its mouth, waiting for what it has swallowed to digest. Albatrosses love to follow in the track of ships, to catch the small fish that come to the surface behind them, and to pounce upon anything which falls overboard. Though they are cowardly birds, they will attack a man in the water. A story is told of a sailor who fell overboard from a French ship, and could not be picked up at once because there was

no boat ready to let down into the water. A flock of albatrosses settled on him and began to peck at his head, and the poor fellow, unable to fight the waves and the birds at the same time, was drowned before his comrades got to him.

The word albatross is from the Portuguese *alcatraz*, a name given by the early sailors of that nation to large sea-birds.

The **Stormy Petrel,** called by sailors Mother Cary's chicken, is the smallest of web-footed birds. It is often seen at sea in all parts of the ocean, even in the most violent storms, which it appears to enjoy. Sailors think the petrels bring stormy weather, and are careful not to hurt them lest they should bring them ill-luck. In calm weather these birds appear to walk along on the surface of the water, for which reason they are named after St. Peter (peterel), who is said in the Bible to have walked on the sea. The people of the island of St. Kilda, who kill the petrel by the thousands, call it the lamp bird, because it is so oily that when a lamp-wick is put into the mouth of one it will burn and give a good light for an hour.

The gull belongs to the order *natatores*, or swimming BIRDS.

The word gull is probably from an old Welsh or Breton word meaning to wail, and the bird is so named on account of its wailing cry.

GUM, the hardened sap of certain trees and plants. Gums will dissolve in water and not in alcohol, while RESINS will dissolve in alcohol, ether, etc., but not in water.

Gum Arabic, the juice of several kinds of acacia trees that grow in Arabia, India, and Africa, will dissolve entirely in water. It is used to thicken common ink and the colors with which calicoes are printed, for dressing muslins and silks, and also as a medicine. Gum Senegal, from Senegal on the western coast of Africa, and Barbary gum, from Morocco, are much like gum arabic. They also are used for dressing fine goods and by confectioners for making gum drops.

Gum Tragacanth, the juice of the goat-thorn, or tragacanth shrub, belongs to another class of gums, which soften and swell in water without dissolving entirely. It is brought mostly from Northern Persia and Asia Minor. It is much used for stiffening fabrics of cotton, linen, and silk, where gloss is not wanted.

The word tragacanth is from the Greek *tragakantha*, which is from *tragos*, a he-goat, and *akantha*, a thorn.

British Gum, or dextrine, a kind of gum made from starch by heating it very hot, or by mixing it with weak nitric acid, is now much used instead of the more costly natural gums for stiffening calicoes and other goods. The gum on postage and revenue stamps is made of this.

A class of gums called gum resins are part gum and part resin. They can be dissolved in a mixture of water and alcohol. Among the gum resins are asafœtida, myrrh, aloes, frankincense, and gamboge.

The word gum is from the old English *gomme*, Latin *gummi*, Greek *hommi*, gum.

GUN. See CANNON; RIFLE.

GUN-COTTON, an explosive cotton which can be used instead of GUNPOWDER. Common cotton is made up of CARBON, OXYGEN, and HYDROGEN; but when it is put into nitric ACID, it takes up from it NITROGEN, which is found in almost all things that will explode.

Gun-cotton is made by soaking cotton-wool in a mixture of nitric and sulphuric acids. The sulphuric acid has no effect on the cotton, but is used to take up water and thus to make the action of the nitric acid more perfect. As soon as the cotton is fully soaked through, the acid is squeezed out of it, and it is washed until all the acid or sour taste is gone. After drying it is ready for use. The way of making it was first found out

in 1846, by two German chemists, named Schönbein and Bottger.

Gun-cotton is more dangerous to make than gunpowder, because it explodes more easily and with much greater force. It costs, too, more than gunpowder, and is apt to take up moisture, when it is unfit for use until dried again. It is not much used now, not even for blasting rocks, as nitro-glycerine, made from GLYCERINE in nearly the same way, is much stronger.

Collodion, much used by photographers to make the film or skin on the glass plates on which they take their pictures, is made out of gun-cotton mixed with alcohol and ether. See also CELLULOID.

The word gun-cotton is made up of GUN and COTTON.

GUNNY. See JUTE.

GUNPOWDER. Common gunpowder is made out of nitre or SALTPETRE, CHARCOAL, and SULPHUR, and all nations make it in nearly the some way, using about seventy-five pounds of nitre, fifteen pounds of charcoal, and ten pounds of sulphur for one hundred pounds of gunpowder. The materials are first made as pure as possible, the nitre being soaked in spring water, then boiled and cooled, then filtered through canvas bags and allowed to harden again. This is done twice until it becomes perfectly white. The sulphur is also purified twice by being kept melted for several hours in gun-metal pots. The charcoal, which is made from dog-wood, alder, or willow, is burned in large vessels of iron instead of in the open air, as most charcoal is made, and must be thoroughly charred and soft.

The three substances are first ground separately to a fine powder, and are then ground together with a little water until they are thoroughly mixed. The mixture, now called "millcake," is next pressed very hard in a hydrostatic press (see WATER) into thin smooth cakes called "press-cake," which is afterward broken up between toothed rollers, and rubbed though sieves until it is made into grains of the right sizes. The next thing is glazing, which is done by putting the grains into canvas bags or into a barrel, which is made to turn round very fast. The grains, by rubbing against each other, are thus worn round and smooth, and get a glaze or polish. This is very important, because glazed powder keeps dry and bears shaking better than other powder. After glazing, the powder is dried in rooms heated by steam pipes.

The making of gunpowder is very dangerous, because it is liable to explode and blow up the mill. When gunpowder explodes, that which was a solid is suddenly turned into a gas, which takes up about two thousand times as much room as the solid did. As this gas must find room for itself, it drives everything out of its way; it blows up the house in which it is stored, splits open rocks in a quarry or mine, or forces a ball out of a cannon. In making FIREWORKS gunpowder is used in many different forms.

History. Gunpowder was probably first made by the Chinese. They used it at first only for making a noise for amusement, or for driving away evil spirits; but early in the seventh century A. D. they made FIREWORKS with it. Soon after this Arab traders carried news of it to Bagdad, and then the Arabian chemists, about the twelfth century, found out how to use it in war. The army of Genghis Khan first used gunpowder in CANNON in China in 1234, and from them the Chinese learned its military use. The western nations of Europe also probably got their knowledge of it from the Arabs.

Smokeless Gunpowder. The explosion of common gunpowder is always attended by a thick suffocating smoke. The reason of this is that the things of which it is made do not all turn into gas, when it is fired, but leave behind a certain amount of solid

matter. Part of this solid matter remains in the gun, and makes it foul, but the greater part, in a state of fine dust, floats off with the gases and makes smoke. To get rid of this smoke, which hides armies from view in battles, and ships in naval engagements, is the object of smokeless gunpowder. Gun-cotton was the first smokeless powder used, but it did not do very well; then various forms of nitro-GELATINE and dynamite were tried, and most smokeless gunpowders are now based on these, mixed, in some cases, with a little camphor. Different nations have different kinds, the method of making which is in some cases kept secret. Thus, the French powder, made by Vieille, is a state secret, as is also that used by the United States, invented by Prof. Munroe. The English have a kind patented in 1886 by Sir Frederick Abel; and in 1887 the Swedish chemist, Alfred Nobel, took out a patent for another, used in Italy and Germany. Nobel's smokeless gunpowder is a whitish-brown composition first made into sheets or plates that look like bone, which are afterward cut up into pieces of any shape. It is much stronger than black gunpowder, and when used in a rifle will carry a ball through twelve inches of plank. It makes as much noise as black gunpowder, but its smoke is only a faint blue cloud, which quickly clears away.

Gunpowder made for use in large cannon is generally made in very

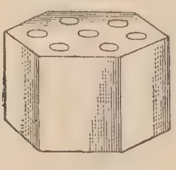


Fig. 1.

large grains, to keep it from exploding too quickly. If a large gun should be loaded with rifle powder, the explosion would be apt to burst the gun, as the gas expands all at once; but with large grains the expansion is more gradual, and gives the shot time to leave the gun before all the force is spent. In Fig. 1 is shown a grain of black gunpowder, called pellet-powder, with holes to give more surface to the flame, for use in heavy guns. It is of

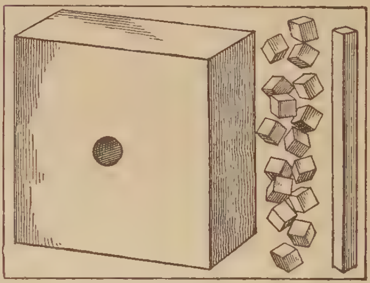


Fig. 2.—Half Natural Size.

the natural size, but even larger gunpowder has been used, in some of which only six grains weigh a pound. In Fig. 2 is shown a grain of smokeless cannon-powder, one-half the natural size. Beside it are small grains and a strip of smokeless gunpowder for smaller guns.

The word gunpowder is made up of gun, from the new Latin *gunna*, a fire tube, and powder, French *poudre*, from Latin *pulvis*, dust.

GUTTA-PERCHA, the dried milky juice of a tree which grows in the Malay Archipelago. The tree is very large, being sometimes three feet thick. The Malays usually cut down the tree, strip off the bark, and scrape off the juice which lies between the wood and the bark; but sometimes they only bore a hole in the tree and catch the sap in gourds. As the juice hardens it is made into large cakes or lumps, and sent to foreign countries. Pure gutta-percha is grayish white, but we usually see it discolored with dirt, and it has to be cleaned before it is fit for use. It is cut up into small pieces by machinery

and softened into a paste with hot water, when it may be rolled or worked into any form. It may be softened at any time and moulded into any shape, which it will keep when it cools. Gutta-percha is made into a great number of things. As it is water-proof it is used for shoe soles, water pipes, and for covering cloth for clothing. Surgeons make splints of it to bind broken limbs to, because by softening it can be fitted to the shape of the limb; dentists fill teeth with it, and chemists use bottles, SYPHONS, and funnels made of it, for acids which will eat glass. Telegraph wires are coated with it, and ink-stands, trays, picture frames, architectural ornaments, etc., are made of it.

The word gutta-percha is from the Malay *gatah*, gum, and *pertja*, the name of the tree from which it comes.

GYPSUM, a soft chalky kind of stone. A fine grained solid kind of gypsum is called ALABASTER, and another kind, so clear that one can see through it, is called selenite. Satin spar is a beautiful kind used for necklaces and inlaid work. Pure gypsum is usually white, yellowish-white, or gray, but is sometimes yellow, red, brown, or black, according to the other things mixed with it. Gypsum baked in ovens and ground to powder makes the white plaster, called **Plaster of Paris**, so much used for making casts, cornices, and ceilings. Ground gypsum is often put on land for manure.

The word gypsum is Latin, and is from the Greek *gupsos*, white lime.

H

HADDOCK, a fish of the cod family, found on the American coast from New York to the Arctic regions, and along the northern coast of Europe. It is one to two feet long and generally weighs two to six pounds, though larger ones are sometimes taken. The color is dark gray above and silver-gray below, with a black streak along the side. Haddock go in immense shoals, which appear on the coast in spring and leave in autumn. They are taken the same as cod, and are good eating when fresh.

The **Norway Haddock** is a different kind of fish, commonly called in the United States rose fish, red perch, and snapper. It is about as large as the haddock, but is bright red, with a black blotch on the gills. It is found on our coast from New York to the far north.

The word haddock is in old English *hadok*, but its origin is unknown.

HAIL. There are two kinds of hail: the small grains, like fine shot, which often fall in winter, but rarely in summer, and which generally come before snow; and larger hail, which falls usually in hot weather, and is most severe in very hot climates. The first kind is caused by the freezing of rain drops as they pass in falling through colder air than that from which they started; the second kind, or common hail, is made by the meeting of two currents of air, one very warm and loaded with vapor, and the other very cold.

It is known, by going up in balloons and in other ways, that the air is not all of the same heat, but is divided up into cold and warm parts or layers, a layer of very cold air, much below freezing, often lying between two warm parts. When bodies of warm damp air move upward into one of these layers of cool dry air, the damp air is at once changed into ice, and hail falls. Sometimes the hailstones thus formed are very small, and sometimes many meet and freeze together into large masses. They are usually not much larger than a walnut or a pigeon's egg, but some have been seen as large as an orange, and in very hot countries hailstones larger than a sheep are said to fall sometimes. In 1860, during a hail storm which took place while an English ship was off the Cape of Good Hope, stones of the size of a half brick fell and hurt many of the sailors. Hailstones often do great harm to crops, especially in France, Germany, and India.

The word hail is from the Anglo-Saxon *hagol*, hail.

HAIR, including bristles, fur, wool, etc., is a part of the skin, and has the same use as feathers in birds and scales in reptiles. Hairs are made up of a shaft and a bulb. The shaft, or part outside of the skin, does not grow: but the bulb, or part under the skin, which is made up of little cells, grows by forming new cells, the old ones being pressed forward and becoming a part of the shaft. Hair is much like horn, and, like it, grows in layers. Its color is caused by a kind of oil which comes from cells in a bulb. In dark hair this oil is dark brown, in red hair it is blood-red, and in fair hair it is yellowish. There is none of this coloring oil in white hair. Straight hair

is nearly round, but curly or crisp hair, like that of the negro, is flattened, and the hair of the Bushman, in Africa, is nearly as flat as a ribbon. But the hair of the negro, though different from that of the European, is real hair, and not wool as some think.

Hair is very strong and very lasting. It is also very elastic, that is, springy, and for this reason is much used for stuffing cushions, mattresses, sofas, etc. The best curled hair is made from the shorter parts of the manes and tails of horses. It is first carded or combed straight between teeth or combs, and twisted into ropes; then soaked in cold water, heated in an oven, and untwisted, when it keeps the curl given it in the rope. The hair of cows and the finer kinds of pigs' hair are sometimes used for making curled hair. The long hairs of horses' tails are woven into hair cloth for covering furniture. As the hairs of different horses are of various colors, they are first dyed black with LOGWOOD and copperas (IRON sulphate). White horse hair can be dyed of any color, and is much used for making fancy hair cloths, especially in South America. White horse hair is also used for making violin bows and fine fishing lines, and is woven into hats and bonnets for women's wear. The kind of cloth called crinoline was at first made of white or gray horse hair, but is now made mostly from the fibre or thready part of the agave or American ALOE.

The weaving of horse-hair cloth differs from other weaving, on account of the shortness of the hairs, which can be used for the weft only, the warp (see CLOTH) being generally of black linen yarn, but sometimes of worsted or cotton. Each thread of weft is a single hair, so that the cloth can be made only as wide as the hairs are long. Horse hair is sometimes twisted into yarn or thread, and woven into sacking, or made into ropes. In Germany cow hair is made into yarn and woven into carpets, and in Norway the peasants make socks of it. The hair of CAMELS, GOATS, and dogs is also used for weaving, and the hair and fur of beavers, rabbits, and other small animals for making FELT. Hogs' hair and bristles are largely used in BRUSH making.

Human hair is used chiefly for making wigs, curls, chignons, beards, moustaches, etc. Most of it comes from France, Italy, and Germany, where young peasant women sell their hair to wandering dealers, who go round the country to collect it. These sell it to hair merchants, who partly dress it, and sell it again to the wig-makers. Light hair comes mostly from Germany, and the darker shades from Italy and France. Human hair is also plaited into ornamental work, such as chains, watch guards, brooches, and various fanciful things, even pictures having been made from it.

The word hair is from the Anglo-Saxon *hær*, hair.

HALIBUT, a large flat sea fish. It sometimes grows to be longer than a man, and weighs 100 to 500 pounds. It is caught by hook and line all along the Atlantic coast from New York northwards. Its flesh is coarse and somewhat dry. The Greenlanders catch halibut by spearing them from their boats with a kind of HARPOON, to which a line is fastened. They salt, dry, and smoke the flesh.

The word halibut, or holibut, as it is sometimes spelled, is from the old English *hali*, holy, and *but*, or *butte*, flounder, so called because eaten on holidays.

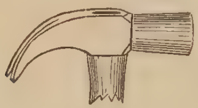
HAMMER. In very ancient times,

Ancient Stone Hammer.

before metals were known, stones were used for hammers, sometimes with and sometimes without a handle.

The handle of a stone hammer was usually made by twisting a withe or small twig of a tree round a crease in the stone, as shown in the picture. Handles like this were put also on stone axes and hatchets.

Hand Hammers are now made of many different sizes and shapes, al-

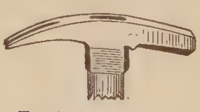


Carpenter's Hammer.

most every kind of trade having a hammer of its own. Several of these are shown in the pictures. Large two-handed hammers, used by

Plumber's Hammer.

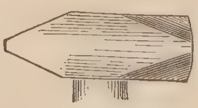
blacksmiths and other metal workers, are called sledge hammers. Heavy wooden hammers, used by woodmen and others to drive wedges into



Farrier's Hammer.

wood, are called beetles, and smaller wooden ones, used by carpenters and joiners, are called mallets.

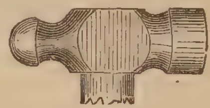
Power Hammers are those which



Blacksmith's Hammer.

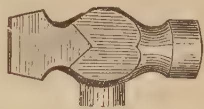
are worked by machinery. Among them are forge hammers, used in forging, or hammering into shape heavy masses of red-hot iron, and tilt hammers, used for lighter work, such as forging bars of shear STEEL.

The forge hammer is a great bar of cast iron, having on one end of it a wrought-iron head, faced with steel,



Machinist's Hammer.

weighing five to ten tons. The other end is made to work on an axle, so that the head can move up and down. The metal to be forged is heated



Engineer's Hammer.

white hot and then lifted by means of a CRANE and put under the hammer, which is raised and let fall by the turning of a wheel 50 to 100

Shoemaker's Hammer.

times in a minute. This hammers the iron into shape and makes it very solid. The tilt hammer works in the

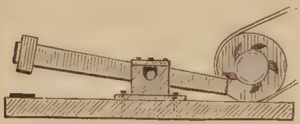
Cooper's Hammer.

same way, only the wheel which moves it is at the other end, which reaches beyond the axle on which it

Coach-Trimmer's Hammer.

moves, as seen in the picture. The hammer is thus made to tilt up and down, and works much faster than the forge hammer.

In large iron works the steam forge hammer is now generally used. In the great Krupp works, at Essen, Germany, is a hammer which cost $580,000. The head, which weighs



Tilt Hammer.

fifty tons, or as much as fifty common loads of coal, is worked up and down by steam. A single workman can so manage it that it will come down with force enough to crush a thick iron bar, or with so gentle a tap that it will not crack a nut-shell. The foundations of this great hammer are 100 feet deep in the ground, and are made up of stonework, heavy oak trunks, and iron bolted together (see ANVIL). Four strong cranes, each able to lift 200 tons, swing great masses of red-hot iron under this hammer, which works very fast and pounds them quickly into shape. A still larger hammer has lately been set up at Bethlehem, Pennsylvania.

Smaller steam hammers, working up and down in much the same way, are used in forging swords, scythes, axes, carpenters' tools, etc.

The word hammer is from the Anglo-Saxon *hamer*, hammer.

HARE. Hares differ from rabbits chiefly in their habits. They do not live in societies, in warrens or burrows dug under ground, as rabbits do, but separately, each one making a nest of grass for itself. They are the enemies of rabbits and fight them when they meet. Hares are found almost all over the world, excepting in Australia. They abound in the United States, where there are several kinds. The jack-rabbit, a kind of hare noted for long legs and ears, is plentiful on western and south-western prairies. The northern hare is found from Virginia to the coldest parts of British America. Its fur in summer is reddish brown, and in winter from white to yellowish gray. It lives on berries, bark, twigs, and buds of trees. It can run very swiftly, and will jump more than three times the length of a man. Hares afford fine sport to the hunter, and in some countries are hunted with hounds. The flesh of those living among hills is very good, and is much used for making soup, but that of hares living in low damp places is not so good for eating.

The hare is easily tamed, if taken young, and becomes very familiar. It is said that Dr. Franklin had one which used to sit before the fire in winter between a large cat and a greyhound, with both of which it lived on the best of terms. It would jump up on the table beside its master and scratch his arm to attract his attention. Hares may be taught many tricks, but they like their liberty so well that they are apt to run away and become wild again.

The hare is a MAMMAL of the order *rodentia*, or gnawing animals.

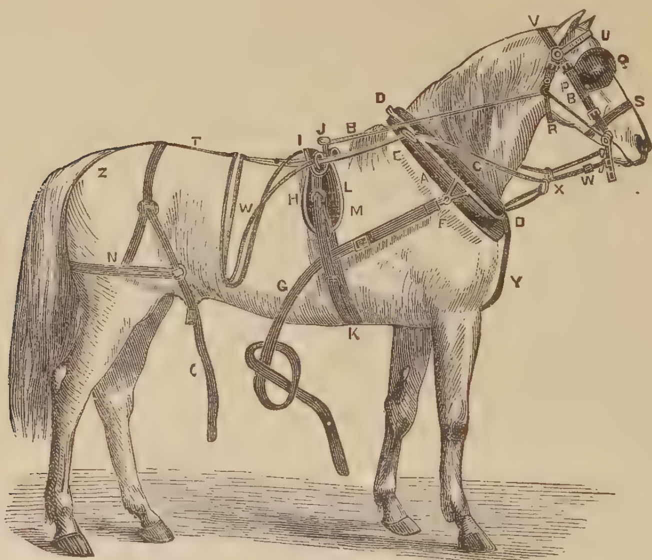
The word hare is from the Anglo-Saxon *hara*, hare.

HARNESS. The parts of a horse's harness will be best understood by studying the picture, which shows a single harness. A harness is made up of four parts: 1, the driving part, or bridle and reins; 2, the drawing part, consisting of the collar, hames and traces; 3, the supporting part, or part for holding up the shafts, made up of the saddle and its parts, and 4, the holding back part, or breeching.

The bridle is made up of a head-piece V, a front-piece U, two cheek-pieces P, two blinders, blinkers, or winkers Q, a nose-band S, and a throat lash R. The bit, or part which goes into the horse's mouth, is made of steel in three general ways, plain, jointed, or curbed. The plain bit, commonly called bar bit, is simply a long round piece of steel, a little bent, with a ring at each end to buckle the straps in; the jointed bit, commonly

called snaffle bit, is in two parts, jointed in the middle, and with rings like the plain bit; the curb bit has a bar on each side, as shown in the picture, with rings at the upper ends in which the cheek-pieces are buckled, and one or more rings on each side at the lower ends into which the reins are buckled. When the reins are pulled, a flat chain fastened in the upper rings of the bars and passing under the horse's jaw is drawn tight so as to hurt, and the driver has thus more command of the horse. When the plain or jointed bit is used alone, it commonly has a small bar at each end to keep the ring from getting into the horse's mouth; but sometimes one of these bits is used with the curb bit, and then it is generally made without bars.

The check-rein or bearing-rein, B B, meant to hold the horse's head in good shape, is also buckled to



Horse with Single Harness.

rings on each side of the bit; it is then passed through leather or metal loops on each side of the throat-lash. and hooked on the check-hook, J, on the saddle. The driving-reins, W W, are buckled into rings in the bit, and then passed through the martingale rings, X. The martingale, which is made up of a strap, Y, fastened to the belly-band, passing between the horse's front legs, and then through a ring in the hames, and ending in two straps, each with a ring on the end, is meant to hold down the head of the horse, so that it may be driven more steadily.

The collar of a harness, A, is an oval ring of leather, fitted to the shoulders, and padded so that the hames shall not hurt the horse. The hames, C, are flat iron bars, sometimes covered with leather, sometimes painted black, and sometimes silver-plated or brass, made to fit into a crease on the collar, and are fastened at the top and bottom by

straps, D D. On each side of the upper part of the hames is a ring, E, called a hame teret, through which the driving-reins pass, and near the bottom a strong metal arm with a ring at its end, in which is fastened the tug, F, of the trace. The trace, G, is a broad, thick leather strap which fastens to the drawing-bar of the carriage, either by means of a hole at its end or of a metal loop or hook. As all the weight of the carriage is borne by the traces, of which there are two, one on each side, they have to be made very strong. Traces may be lengthened or shortened by means of a buckle seen near the letter M in the picture.

On the supporting part of the harness, H is the saddle or pad, which has on its front a hook, J, for the check-rein, and on each side a ring, I, called a teret, through which the driving-reins pass. The saddle, which is usually made of patent LEATHER, and padded underneath, is fastened to the horse by means of the belly-band, K, which buckles round the horse. A strong leather strap, L, called the back-band, passes along the middle of the saddle and buckles round on the belly-band. Under it and fastened to it, on each side, is a stout leather loop, M, called the shaft-tug, into which the shafts of the carriages are put. The saddle is kept in its place by a back-strap, T, which runs from it to the crupper, Z, a round strap passing around the root of the horse's tail. The carriage is kept from running on to the horse's heels by the breeching, N, which passes round the animal's quarters, and is fastened to the shafts by the breeching-straps, O, of which there is one on each side.

Some single harnesses are made different from this one. Instead of a hames collar, a breast collar is often used, especially for light carriages, made up simply of a broad band, to the ends of which the traces are buckled, running round the breast of the horse, and held in place by another strap buckled near its ends and passing over the neck just in front of the withers. In some harnesses, too, the saddle and the straps under it are different, and a strap called a kicking-strap is put round the horse's quarters instead of the breeching. Double harnesses are made much like single ones, but differ from them in some things, which cannot be easily told about without a picture, but which can be easily seen by looking at any pair of harnessed horses.

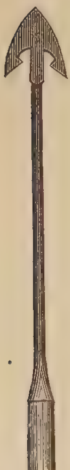
After a horse is harnessed, it is put to the carriage or wagon by first slipping the shafts through the tugs, M. The traces should then be hitched to the drawing-bar, care being taken to fasten them so that they cannot get off. The breeching should next be buckled, and then the belly-band. After this the reins should be taken in hand, and the driver may then get in and take his seat.

The word harness, French *harnois*, once meant the armor of a soldier, which was fastened on with straps and buckles.

HARP, a musical instrument shaped like a triangle, and strung with wires and catgut cords from the upper part to one of the sides. It is played by pulling the strings with the thumbs and fingers. The harp is a very ancient instrument, and is pictured on the Egyptian monuments, but it was very imperfect until the beginning of this century, when the double-action pedals were added to it. There are seven pedals (Latin, *pes*, plural *pedes*, the foot, so called because they are worked by the foot) on the best harps, by using which the tones of the strings can be made higher or lower as the player wishes. The harp is now used sometimes in an ORCHESTRA.

The word harp is from the Anglo-Saxon *hearp*.

HARPOON, a kind of spear used for killing whales and other large fish. There are several kinds, but the simplest form is an iron spear about five feet long, with a sharp flat point with barbs, as shown in the picture. The edges of the point are made sharp so that it will go into the whale easily, and when in the barbs keep it from pulling out.


Harpoon.

The gun harpoon is a short bar of iron, with a chain and ring at the end to fasten the rope to. This is fired from a small cannon in the bow of the boat. Sometimes glass tubes filled with a strong poison are so fitted into the harpoon that they will break as soon as the line is drawn tight. But the American harpoon-ball, called the "bomb-lance," is now chiefly used in whale-fishing. This is a pointed cast-iron tube filled with gunpowder, which is fired from a gun. A few seconds after it has been shot into the whale a dull sound is heard—made by the bomb bursting inside its body. The whale turns a somersault, and dies very soon, sometimes at once. Poison is also sometimes put into the bomb, but sailors prefer it without it, as they do not like to handle the flesh of a whale killed by poison.

The word harpoon is in French *harpon*, which is from *harper*, to to seize or grasp.

HARROW, an instrument used by farmers for breaking up lumps of earth and smoothing ploughed land. Harrows are made usually of wood in the shape of a triangle, a square, or an oblong, with fixed rows of strong iron teeth or spikes pointing downward; but some are made wholly of iron. When drawn over the ground by horses these teeth smooth the soil and make it fit for planting, or cover up the seeds already sown.

The word harrow is from the old English *harowe*, Anglo-Saxon *hearge*, harrow.

HARTSHORN. See AMMONIA.

HAT. Besides STRAW hats, there are two kinds of hats in common use, felt hats and silk hats. FELT hats are made of felted fur or wool. The chief kind of fur used is that of rabbits and hares, but the fur of the muskrat, and that of the coypu, a Brazilian animal about as large as the beaver, is sometimes mixed with them. After the fur on the skins has been thoroughly cleaned, it is cut off by a machine. The different kinds are then mixed together with a little cotton in the picking machine; the fur next passes through the blowing machine, which separates all the coarse hairs and the dust from the finer fur, and it is then ready to be made into a hat body.

Hat bodies were once formed by hand, but they are now made on a machine. In this machine there is a hollow vessel of copper, shaped like a cone or sugar-loaf, and punched full of little holes, which is made to turn round slowly. Inside of this a kind of fan buzzes round about 4000 times every minute, making the air rush in from the outside through all the holes. When the fur is put into the machine it is blown little by little against the outside of the copper cone, and as the air is always drawing toward the inside, it is spread evenly all over the top and sides, and matted together so as to make a covering of just the shape of the cone. As soon as this is done, a workman wraps a wet cloth around it, puts a copper cover over that, and then takes off the whole, cone and all, and sets it in a tank of hot water, while a new cone is put into the machine for another hat body to form on. The hot water thickens and makes tougher the mat on the cone, which is called the "shell,"

and which is soon taken off and squeezed and pressed. The hat thus far is nothing but an open bag, shaped like a sugar-loaf. It now passes to the hatter, who generally buys his felt hats in this form.

The hatter first dips the shells into hot water, and rubs them together on a table. This, which is called "sizing" them, makes them smaller and thicker. They are next dyed and then "blocked," which means stretching them over a wooden block of the size and shape of the hat to be made. After this they are "pounced," that is, the rough surface is smoothed in a machine by means of an EMERY wheel. The hat is now blocked again and the brim is curled, and it is then finished by girls, who bind it, put on the ribbon, and put in the lining.

Silk Hats are made of a body of muslin, stiffened with a varnish of shell-LAC, AMMONIA, and water. The brim of the hat needs five or six thicknesses of muslin, and the top and sides only one or two. The pieces are fitted together over a wooden block, the side being put on first, then the top, and lastly the brim. These are fastened together with strips of thin muslin wet with varnish and ironed down. When the body is dry it is covered with the silk plush, the best kind of which is brought from Lyons in France. The piece on the under side of the rim is first ironed on, the heat of the iron softening the varnish and causing the silk to stick. The upper side of the rim is next covered, and lastly the top and sides. The round piece for the top is sewed to the side before it is put on, and the whole is then slipped over and ironed down until it sticks firmly to the body, care being taken to hide the seams. The hat is then lined and trimmed, and afterward finished with the iron.

The word hat is from the Anglo-Saxon *hät*, hat.

HAUTBOY, or **OBOE,** a wind musical instrument, used in ORCHESTRAS and bands. It is shaped much like a CLARINET, but is thinner, and has more keys. It is made of wood, usually of box, ebony, cocoa, or rosewood, and in three jointed pieces. In the upper joint is fitted a mouth-piece made up of a small brass tube with a reed or tongue in its end, much like the reed in a clarinet. The hautboy has a piercing sound, but its notes are rich. It was once used only in military bands, but it is now a part of all orchestras.

The word hautboy is made from the French *haut bois* (high wood), and the instrument is so named from its high piercing sound. The Italian form of the word, *oboe*, is now generally used instead of hautboy.

HAWK. The birds commonly called hawks belong to the FALCON family, but they are smaller and their wings are shorter than those of the true falcons. There are several kinds in the United States, among which are the goshawk, the hen-hawk, the FISH-HAWK, the pigeon-hawk, the sparrow-hawk, Cooper's hawk, and the sharp-shinned hawk.

The **Goshawk** (goose-hawk) is the largest of these birds, being more like the falcons than any other hawks, and in old times was used in hawking to catch hares, rabbits, and birds which do not fly very high. It feeds chiefly on wild pigeons, ducks, and grouse, and often hovers over poultry yards, swooping down upon a chicken or a duck and flying off with it before the farmer can get out his gun. The goshawk builds a large coarse nest in trees, and lays bluish-white eggs marked with light-brown spots.

The **Hen-Hawk,** sometimes called also the marsh-hawk and the harrier, is not quite as large as the goshawk. It is found in almost all parts of the United States, and is often seen in flocks. It does not fly very high, but skims along over the fields looking for crickets, lizards, small snakes, frogs, and small birds, on which it chiefly feeds. It loves

to visit hen yards to steal chickens, but a common hen can easily drive it off. The hen-hawk usually builds its nest of dried grasses in a hollow scooped in the ground, and lays three or four bluish-white eggs, marked sometimes with reddish brown.

Pigeon- and **Sparrow-Hawks** live mostly on young birds. **Cooper's Hawk** is one of the boldest of hawks and will attack birds larger than itself. It feeds chiefly on grouse, quails, pigeons, and hares. The sharp-shinned hawk is also very bold, and will seize prey too heavy for it to carry off.

Hawks belong to the order *raptores*, or BIRDS of prey.

The word hawk is made from the Saxon *hafoc;* from which also comes our word havoc, meaning waste or destruction, on account of the cruelty of the hawk.

HAWTHORN, a thorny shrub or small tree much used in England for hedges. It grows wild throughout Europe, Siberia, northern Africa, and Central Asia, and does well in the United States, where it has been planted. It varies in height from six or eight to twenty-five feet. Its leaves are lobed and toothed, and its flowers, generally white, though sometimes rose-colored and even deep crimson, are followed by a small red fruit called haw, which hangs on the tree long after the leaves have fallen and gives the birds food in winter. The hawthorn is often called in England, may, from the season of its blooming; and some think that from it was named the *Mayflower*, the ship that brought the Pilgrim Fathers to Plymouth.

In England the hawthorn is the best plant for hedges, both on account of its thorns and its beauty, but it does not do well for hedges in the United States. It makes a very handsome ornamental tree for lawns. The wood is hard, close-grained, and takes a fine polish.

The word hawthorn means hedge-thorn; it is from the Anglo-Saxon *haga*, a fence or hedge, and thorn.

HAY, grass cut and cured for fodder. After being mown with the scythe or mowing machine, and as soon as the dew is off, the grass is shaken up and spread out with forks or with a tedding machine. Before evening it is raked up into windrows, and, if it looks like rain, is made into small cocks. In the morning, if the weather is good, it is again spread out, and this is kept up usually two or three days, until it is dry, when it is put into stacks or packed into mows in a barn.

When grass is cut in bloom, as it ought to be, because then its stems are the most tender, it has to be dried with care, as it is full of sap. If it is put into the mow before it is fully dry, it will become heated and dark colored, and cattle and horses will not eat it as well as good hay. If it is wet with rain or dew when it is put away, it will mould. Hay that has been wet and dried several times is usually salted to give it a better flavor.

The word hay is from the Anglo-Saxon *heag*, hay.

HAZEL-NUT, the fruit of the hazel bush. The common American hazel bush grows about as high as a man, and is among the first of the trees to blossom in spring. The fruit, which is covered with a bearded husk, is a nut with a hard shell and a large sweet kernel. In England the hazel is much cultivated for its nuts. Those with a long husk are called filberts (full beard), those with a short husk hazel-nuts, and the round hard-shelled nuts cob-nuts. Most of the filberts brought to the United States come from Spain and other parts of the south of Europe. The wood of the hazel is used for making crates, hoops, and whip handles. Its charcoal makes good crayons, and a valuable oil is pressed from its nuts.

The word hazel is from the Anglo-Saxon *häsel*, hazel.

HEAT. There is no such thing as cold. When we say that a thing is cold, we mean only that it has but little heat in it, for everything, even ice, has some heat in it. We can measure the amount of heat in different things, and we know a great deal about how it acts, but we do not really know what it is. Heat is never alone by itself, but is always with something else: we may have hot air, hot water, and hot iron, but no one can divide the heat from the air, water, or iron, and keep it divided. We can easily make heat pass from one thing into another thing, because when things which have different amounts of heat in them are put together, the heat will spread itself around so as to make all of the same heat. A piece of iron put into burning coals becomes hot because the heat passes from the coals into the iron until both have the same amount of heat in them.

Most of the heat in the world comes with the LIGHT from the SUN. We can easily set fire to things by gathering together the sun's rays and bringing them to a point with a LENS called a burning-glass. Heat and light also come together from the fires which we make, but the two will not pass together through glass so easily as the heat and light from the sun. If you hold a pane of glass between your face and the fire, the light will pass through quickly, but the heat will be nearly stopped by the glass; yet both the light and the heat from the sun pass easily through windows. We do not know the exact reason of the difference between these two heats. The sun is a great storehouse of heat, from which the earth gets its warmth and which makes it possible for us to live. It is now believed that the sun's heat, like its light, is only another form of ELECTRICITY.

But all heat does not have light with it, for all animals have heat in their bodies, made by the union of OXYGEN, which they breathe in with the AIR, and the CARBON and HYDROGEN of the blood. This union is a kind of burning, which is always going on within us, but without making any light. Our bodies are thus not made warm by any outside fire or by clothing, but by the burning within us. As the air and other things around us are usually colder than our bodies, they are all the time taking away the heat from us; for, as told before, heat always tries to spread itself around so as to make all things of an equal heat. Fires and clothing therefore do not really give us heat, but make us warm by keeping the heat in our bodies from passing off into the air. The fur of animals and the feathers of birds act in the same way, and they are always thicker in winter than in summer. More heat is made in active or lively animals than in those which move slowly. When you run fast you become much warmer than when you stand or sit still. This is because it makes your heart beat quicker, and this causes the blood to move faster through your body and make more heat. When your body gets warmer than it ought to be, you perspire, and the perspiration then turns into vapor and carries off the heat with it into the air. Animals which usually have the most heat in them cannot bear a lower amount of heat as well as those which do not have so much heat in them. Thus birds, which are always moving, and thus have the most heat in them, cannot stand cold weather, and this is the reason why so many kinds go south in the winter; but fishes, whose blood usually has only as much heat in it as the water, can be frozen up in ice and live.

Just as the union of oxygen and carbon in the blood causes heat, so the union of other substances will do the same thing. Thus, if we mix sulphuric acid and water together the mixture will become very hot. The same thing will happen if we pour water on to lime. In doing

this we do not make any heat, but as all things have heat in them we merely wake up this heat in two things by mixing them together. Heat is also waked up in things by pounding or by rubbing them. When a blacksmith strikes a piece of cold iron on his anvil with his hammer, he wakes up the heat in it, and by striking it long enough he can make it quite hot. If two pieces of dry wood be rubbed together long enough sufficient heat will be waked up in them to set them in a blaze, as is told about the article FIRE. When carriage wheels are dry and fit too tightly, they sometimes catch fire. This is because the wheel rubs hard on the axle and wakes up its heat.

Heat tries to spread itself in every direction in three ways. First, by touching, as when a hot thing is put on a cold thing; the heat passes from one into the other, and the two thus get an equal amount of heat. Secondly, by conduction, as when heat travels from one end of a thing to the other end. For instance, if one end of an iron bar be put into a fire the heat will spread all through it. Heat thus spread is said to be conducted. A piece of wood burning at one end becomes only slightly heated at the other end. Hence some things are said to be good conductors of heat, and others bad conductors. The metals are the best conductors of heat; glass is a poor conductor, and wood a still poorer one. This is the reason why iron tools used in fires have wooden handles fitted to them. Such things as hair, fur, feathers, and wool are also bad conductors of heat; and this is why they keep heat from passing off from the bodies of animals. We wrap ice up in flannel because flannel is a bad conductor of heat, and keeps the heat of the air from getting to the ice. A third way in which heat travels is called radiation. This is where a thing is warmed by putting it before a fire, but not touching it. The heat passes over to it, or is radiated to it, from the fire. Rough things always radiate more heat than smooth ones.

All things, whether solid, liquid, or gaseous, are expanded, or made larger, by adding to their heat. If a bar of iron which will just go through a hole be heated, it will be swelled so that it will no longer go through it. This is of value in fixing tires on wheels. The tire is made a little too small for the wheel, and is then expanded or enlarged by heating it, when it is easily slipped on. When it cools it becomes of the same size as it was at first and fits so tightly that it binds all parts of the wheel firmly together. In laying tracks on railroads the rails are always put a little way apart at the ends; if they were laid close together they would expand on a very warm day and push each other out of place. If a flask full of water be heated the water will expand and run over. Molasses and oil do not weigh so much in summer as in winter, because they are swelled and made thinner by heat, so that there is a less amount in a gallon than when it is cold. The mercury or alcohol in the bulb of a THERMOMETER is expanded by heat and rises up in the tube; the more heat there is the higher it rises; and in this way we are enabled to measure the amount of heat. AIR and other gases are also expanded by heat. During summer the earth becomes heated by the sun, and then heats the air above it. This warm air rises and cooler air rushes in to take its place, and this makes a breeze. There are some things which are not expanded or made larger, like other things, by adding to their heat. If boiling water be cooled it will become smaller in bulk only until it reaches a certain point (39° F.), and then it will begin to expand again until it is frozen; so that water really grows larger instead of smaller by freezing. This is very important, for if it were not so water would be-

gin to freeze at the bottom, and all lakes and ponds would become so filled up with ice that they would not thaw out in summer. But now, as water swells in bulk, as it gets near the freezing point, it rises to the surface, and the ice is first formed on the top.

When a solid thing turns into a liquid thing, or when a liquid thing turns into a gas (see ELEMENT), a great deal of heat is used up. For instance, if the two solids, salt and ice, be mixed together, they will turn into a liquid which will be very much colder than the two things of which it was made. This is because they absorb or take up a good deal of heat in passing from the solid to the liquid state. Such a mixture is called a freezing mixture, and is much used in freezing ice cream and other things. The cream to be frozen is put into a tin pail which sits in another pail so that it is surrounded on all sides by the mixture of ice and salt. The outer pail is usually of wood, which is a non-conductor of heat, and as the ice and salt need heat to melt they draw it from the cream, which is thus frozen.

In the same way, when a liquid turns into a gas it needs a great deal of heat and gets it wherever it can. If a little ether be poured on the hand, it soon flies away as a gas, and leaves the hand very cold. This is because it has drawn a good deal of heat out of the hand in order to turn into gas. If a pan of water be put under the receiver of an AIR-PUMP beside a pan with some strong SULPHURIC ACID in it, and the air be then pumped out, the water will evaporate or turn to vapor very fast, and in doing so will draw so much heat from itself that it will turn into ice. Much artificial ice is now made in hot countries by machines which work on this principle.

The word heat is from the Anglo-Saxon *hætu*, heat.

HEATH, or HEATHER, the common name of a large family of plants, to which belong also the rhododendron, the azalia, the kalmia, and other beautiful flowering shrubs. In Western Africa, where most of the heaths grow, they are often 8 to 10 feet, but in northern countries they are seldom more than a foot high. The common heath of Great Britain, called sometimes ling, and in Scotland always heather, is so striking a feature in the landscape that it has long been the theme of poetry and song. The flowers, which look as if they grew in spikes, are of a lilac-rose color, rarely white. When in full bloom in Scotland, at the end of August, they give the hillsides a purple glow which is very beautiful. Mixed with the common heather is often found the bell-heather, the flowers of which are magenta-colored bells, the heather bells of Scottish song. This kind also is sometimes, though rarely, pure white; to find a sprig of white heather of any kind is considered good luck. The common heather grows wild in some parts of New England and Nova Scotia.

The heather has many uses: cottages are thatched with it, fences wattled with it, and ropes, baskets, brooms, and scrubbing brushes made of it. The flowers contain much honey, and beehives are taken to the moors when the heather is in bloom. In some of the Hebrides, it is used for tanning leather, and in Italy the young shoots are mixed with malt in making ale. This is supposed to be the same kind of beer made by the ancient Picts.

The word heath, in old English *heth*, means both the plant and the waste land where it commonly grows.

HEDGEHOG. There are no hedgehogs in America, though the name is sometimes wrongly given to the Canadian *porcupine*. The hedgehog proper, which is common in Europe, is about nine inches long. The under parts are covered with brownish white fur, and the upper

part with sharp prickles about an inch long. When attacked it rolls itself into a ball presenting on all sides a thorny mass which no animal dare attack. The hedgehog hides during the day in burrows and hedges, and comes out at night in search of insects, grubs, snails, and fruits. It is sometimes called urchin, a name which grew out of its old Greek name, *echinos*.

The hedgehog belongs to the order *insectivora*, or insect-eating animals.

HEMLOCK, or **HEMLOCK SPRUCE,** an evergreen cone-bearing tree, common in North America. It grows chiefly on the northern borders of the United States and in Canada, where there are vast forests of it. It is a beautiful tree when it stands alone, forming a pyramid of green from the ground to the top, which is sometimes 100 feet high, or higher than a very tall house; but when it grows in a forest its trunk is usually without branches most of the way up. From the hemlock is got a good deal of common lumber, it being much used for beams and rafters, and for sheathing, or the covering of houses under the shingles and clapboards. Hemlock bark is largely used in tanning leather, and many trees are killed by stripping them and leaving them to decay.

Socrates is said to have been put to death by being forced to take a dose of hemlock poison. This was not the juice of the hemlock spruce, which is not poisonous, but probably of a plant called poison hemlock or conium, which does not grow as tall as a man. Some think it was the juice of the water hemlock, another small plant.

The word hemlock is from the Anglo-Saxon *hemlic*, which means the poison hemlock.

HEMP. The hemp plant, which grows in many parts of the world, is raised every year from the seed. It is sometimes only three to four feet high, and sometimes more than twice as high as a man, according to the richness of the soil and the heat of the climate. The stem is hollow, or filled with a soft pith; around the pith is a tender woody substance, and outside of that is the bark, made up of strong threads covered with a thin outer skin.

When the hemp is ripe the plants are pulled up, the leaves, flowers, and roots cut off, and the stalks tied up in bundles. The next thing is the retting or rotting of the stalks by soaking them in water to soften the vegetable glue which holds the threads together. After this has been done, they are dried, either in the sun, in warm rooms, or in ovens. They are then "broken," "scutched," and "hackled" in the same way as FLAX. After spinning, the hemp is woven into various kinds of heavy cloths, such as CANVAS, tent-cloth, sail-cloth, bagging, and sacking, and also into many kinds of cordage and ROPES. See JUTE and MANILA.

The word hemp is from the Anglo-Saxon *henep*, hemp.

HERON, the name of a family of BIRDS which includes, besides the herons proper, the egrets and bitterns. The body is small for the length of the neck and the legs. The legs are very long and slender, and the bill is longer than the head, and comes to a sharp point. When the heron flies the head and neck are stretched out straight in front of the body and the long legs are stretched out straight behind. Herons feed mostly on fish, frogs, crabs, and other water animals, and they may often be seen standing quietly in shallow water along the edges of rivers or lakes, or along the sea shore, watching for fish. As soon as a fish comes along it is seized in the long bill and swallowed at once. Herons build their nests in high trees near the water, and feed their young with fish until they are old enough to care for themselves.

There are several kinds of herons in the United States, including the Louisiana heron, of a slaty blue color; the snowy heron and the great white heron, both pure white; the great blue heron or blue crane, with a bluish body and a black head; the great American egret and the great white egret, which are white; and the green bittern or heron.

The European heron was the bird most hunted when falconry or hawking was in fashion. It has a beautiful black glossy crest on the back of the head, which in old times was much valued as an ornament, and was worn only by nobles. It still forms the centre of the white ostrich plume in the caps of Knights of the Garter. The flesh of the heron was in old times thought to be very fine eating, and was served only on the tables of the rich and great. In order to get this delicacy more easily, places called heronries were made in forests on the lands of nobles, where they were allowed to live and breed in peace until they were wanted for the table. Heron's flesh is not now much eaten, but in England some great families still keep up the heronries on their estates in memory of the olden time.

The heron belongs to the order *grallatores*, or wading BIRDS.

The word heron is in French *héron*, and the bird was probably so named from its harsh cry.

HERRING, the name of a family of FISHES which includes the true herring, the ALEWIFE, the SHAD, the whitebait, the sprat, the SARDINE, and the ANCHOVY. The true herrings are sea-fishes, and never go up rivers to spawn, as shad and some other fish do. They appear almost every spring, summer, and autumn, in vast numbers, on the shores of Europe, Asia, and America, swimming near the top of the water, and followed by multitudes of larger fishes and by gulls, fish-hawks, and other sea-birds, which feed on them. In the winter they go off into deep water.

The herring has a large mouth and the under jaw sticks out a little beyond the upper one, as is shown in the picture. The gills have very long fringes, which become stuck

Head of Herring.

together when the fish is out of the water, so that it lives but a short time. From this comes the common saying, "as dead as a herring." Herrings love to swim with their noses out of water, as if to breathe the air, and as millions of them rush along, they make a sound like the falling of heavy rain. The back of the herring is greenish blue, and its sides and lower parts are covered with silvery scales, sometimes marked with figures which ignorant fishermen look upon with wonder. About three hundred years ago, two herrings were caught off the coast of Norway, which had on their sides marks that looked somewhat like Gothic letters. They were sent to the King of Norway, who turned pale when he saw the marks, for he thought they foretold his death and that of his queen. Learned men were called to look at them, and some read them in one way and some in another; but the king died the next year, and all the people thought that the two herrings had been sent from heaven to warn him of his coming death.

The herring is one of the most important of all fishes, and the herring fishery is more valuable than any other excepting that of the cod. In Northern Europe it is called the great fishery, while that of the whale is called the little fishery. The

wealth of Holland was built up chiefly by it, and there is a saying in that country that Amsterdam is founded on herring heads. The herring fishery is also largely carried on by the English, Norwegians, Danes, and French in Europe, and by the New England States and by Canada in America. The chief fisheries here are off the coasts of Maine, Newfoundland, and Labrador.

Herring are caught mostly in drift NETS, though some are taken in seines. The drift nets, which are set usually in the evening, are sometimes a mile long, and reach down into the water more than thirty feet, or five times the length of a man. The herrings try to get through the meshes and are caught and held tight by the gills. When enough have been taken to fill the boats the fish are taken to the shore, where they are cleaned, salted, and packed in barrels. These are called white herrings; those which are salted and smoked are called red herrings. Some which are smoked only a little, and are intended to be eaten at once, are called bloaters. The English whitebait is the young of the herring.

The word herring is from the Anglo-Saxon *hering*, which is from *here*, an army, and the fish gets its name because it moves in such numbers.

HICKORY, a large tree of the same family with the WALNUT, found only in America. There are several kinds, all of which are beautiful and stately trees. The shellbark or shagbark hickory, so called because its shaggy outer bark peels off in long strips, bears the common hickory nut, which is sometimes wrongly called walnut. In the Western States grows another kind of shellbark, with nuts twice as large as the hickory nut, but they are not so sweet. The pecan hickory, which grows in the Southwestern States, yields the pecan nut. The pig nut is also a kind of hickory.

The wood of the hickory makes the best of fuel and of charcoal. It also makes good timber, but rots fast from heat and dampness, and is much eaten by worms. It is, however, very tough, and is used for making carriage shafts, wheel spokes, whip handles, large screws, hoops for casks, etc.

The word hickory is shortened from pohickory, which is made from *pawcohiccora*, the Indian name of a kind of oily milk made from pounded hickory nuts.

HIPPOPOTAMUS. This animal is found only in Africa. It is usually not quite so high as a man, but its body is nearly as large as that of the elephant. Its legs are very short, which makes it awkward in its movements. Its skin is as much as two inches thick in some places, is a dirty brown color, and has no hair on it. The hippopotamus passes much of its time in the water of rivers and lakes, especially during the day, leaving it at night to feed on the grass and herbage along the banks. It swims and dives with great ease, and can stay a long time under water. The female often swims with a young one standing on her back. The hippopotamus is usually harmless, but when attacked is dangerous, and will sometimes smash a boat to pieces. It is much hunted by the Africans for its flesh, which is like pork, and for its hide, out of which are made shields, helmets, whips, and canes. Hippopotamus teeth are large and are much valued for their ivory. Dentists sometimes make false teeth out of them.

In 1872 a baby hippopotamus was born in the Zoölogical Gardens in London, and much has been learned about these animals by watching it. A few days after its birth its keeper was looking at it swimming about in the tank with its mother, when all at once it dived under the water. Its keeper expected to see it come up again every minute, but it stayed

under so long that he began to think it was drowned, and he was just about to order the water let out of the tank, when little "hippo" came up from the bottom, shaking his funny little horselike ears, and looking as bright as if he had only taken a dip. Yet he had been under the water, without taking breath, for nearly twenty minutes. His parents had never been known to stay under more than three minutes at a time. It was afterward found out that the little fellow went under water to suck, and it is supposed that the young of these animals have the power of staying under water longer than the old ones so that they may be safe from their enemies while they are weak.

This baby "hippo" was at first so small that he could go through the bars of the cage, but he soon grew too large for that. When a few weeks old, he was about the size of a fat pig, and his hide was of a pinkish-slate color. He soon learned to know his keeper, and when he had had his dinner he was as playful as a kitten, jumping about his cage and throwing up mouthfuls of hay like a young calf. When he began to cut his teeth he used to put his head through the bars to have his gums rubbed.

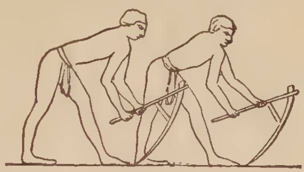
Pictures of the hippopotamus are shown on ancient monuments and medals. A live one was carried to Rome in the first century before Christ, and the Emperor Augustus also showed one there after his triumph over Cleopatra. Others were taken there by later emperors, but after the fall of Rome none was again seen in Europe until the present century, when living ones were got for the London, the Paris, and other zoölogical gardens. Within a few years one has been shown in the United States. They are getting very scarce now in Africa, and will probably soon be all gone.

The hippopotamus is a MAMMAL of the order *pachydermata*, or thick-skinned animals.

The word hippopotamus means river horse, and is made up of the Greek words *hippos*, horse, and *potamos*, river.

HOCK, a light yellowish wine made at Hochheim (from which place it takes its name), on the river Main, in Germany. It is either still or sparkling (see WINE). Sparkling hock is made in the same way as CHAMPAGNE, and is often sold for it.

HOE, a tool used in gardening and farming. There are two kinds of hand hoes, draw hoes and push hoes. The draw or common hoe is used mostly for stirring the soil around growing crops, drawing the earth up to plants, and clearing weeds from among them. In the Southern States, where the soil is



Ancient Egyptian Hoes.

often stiff and hard, very heavy and sharp hoes are used. Push hoes are used chiefly to cut up weeds and to thin out beds of vegetables. The horse hoe, now much used in farming, is made up of a number of small hoes fastened to a wooden frame, which is drawn by a horse. It can only be used to hoe crops sown in straight lines called drills, between which the horse can walk.

The word hoe is in French *houe*, which is from *houer*, to dig up.

HOG. The hog was not known in America and Australia before they were settled by white men, and all the hogs now in those countries, both tame and wild, are descended from those which were brought from Europe by the early colonists. In South America there are immense

droves of wild hogs in the forests, and in many of the Southern and Western States the woods are full of half wild ones, which live on acorns, beechnuts, and other vegetable food. These hogs are much cleaner in their habits than tame hogs; indeed, the filth of the domestic hog is largely owing to the way in which it is kept, and it will always keep its sleeping place clean if it can. It wallows in the mud to cool its skin and to drive away insects, but elephants and other thick-skinned animals do the same thing.

The wild boar of Europe, which belongs to the same family with the common hog, is fond of rolling in mud, but washes itself when it can in ponds or brooks before going to its sleeping place. These animals are very fierce, and hunting them is very exciting and dangerous sport. When chased with dogs they run away very fast and will not turn out of the path for anything; but if wounded, will rush upon the hunters and fight hard. A wild boar will sometimes rip up a dog or a horse with its long sharp tusks, and sometimes even kill a man. In Germany boars are hunted usually by men on horseback, with spears, though they are sometimes shot.

Some think the common hog is descended from the wild boar, but it is not certainly known. The male of the hog is called a boar, and the female a sow. The young are called pigs, and those about half-grown shoats. There are many different breeds or kinds of hogs, mostly made by the different ways in which they are brought up and fed. Indeed, the tame hog may be said to have been almost made by man, it differs so much in shape and habits from the wild hog.

The hog is one of the most valuable of all animals. Its flesh is eaten by most nations in many forms, as pork, fresh and salted, bacon, ham, sausage, etc.; its fat is made into lard; its skin into leather, used by saddlers, harness-makers, and trunk-makers; and its bristles, or coarse hairs, are made into many kinds of brushes, especially tooth, nail, and hair brushes. Great numbers of hogs are raised in the Western States, where the killing, curing, and packing of pork is a very large business. The most pork is packed in Chicago and Cincinnati, more than two million hogs being usually killed every year in those places.

In some countries the hog is made useful to man during its life. In China pigs are harnessed and made to draw wagons, and in some parts of France they are taught to hunt truffles (see FUNGI). In Northern France they are tied up to apple trees so that they may root up and loosen the earth around them.

The hog is a MAMMAL of the order *pachydermata*, or thick-skinned animals.

The word hog is spelled *hoch* in the Cornish and Breton languages. In the Breton language *houc'ha* means to grunt.

HOLLY, an evergreen tree of the ilex family, common on the Atlantic coast of the United States from Maine southward. In the north it is a low tree, but in Virginia and other Southern States it is sometimes 30 to 40 feet high. It has gray bark and shiny green leaves with spiny teeth, and bears bright scarlet berries. It differs somewhat from the European holly, which has more glossy leaves and brighter berries, and is not so hardy. In Great Britain the holly is very long lived, some trees being said to be more than a thousand years old. It is much used to make hedges and is grown in parks for ornament. Its branches with its scarlet berries are favorites for Christmas decorations, and quantities of it are brought to New York from New Jersey and Long Island and sold for this purpose. Holly wood, which is white and fine-grained, is much used for turning and for cabinet work, being some-

times dyed black to represent ebony. Bird lime is made from the inner bark.

Holly is the Anglo-Saxon *holen*, holy, the tree being considered holy because its branches are used to trim churches at Christmas.

HOLLYHOCK. This flower, once so common in New England gardens, was brought to this country by the early emigrants from England, where it was introduced from Syria toward the end of the sixteenth century. The original hollyhock was single and of a rose-purple color, but it has been changed greatly by cultivation. Double ones of great beauty are now common, and there are many colors, from white through all shades of yellow, pink, and red, to purple, the last sometimes so dark as to be almost black. Some too, are beautifully variegated, and some have the under side of the petals of a different color from the upper side. Though it is commonly a tall plant, gardeners have produced dwarfed kinds that make handsome bed plants.

HONE, or **WHETSTONE,** a hard kind of stone with a smooth surface, used for sharpening tools. The finest hones are those called oil-stones, because they are wet with oil when used. The best stone for hones comes from Turkey, but a very fine kind is brought from Nova Scotia, and another kind from Arkansas. The coarser hones are usually called whetstones, and are wet with water. Whetstones for sharpening scythes, and stripes of wood, covered with EMERY, used for the same purpose, are sometimes called rifles in the United States.

The word hone is from the Anglo-Saxon *han*, whetstone. Whetstone is made up of the Anglo-Saxon *hwettan*, to rub, and *stan*, stone.

HONEY, the sweet juices of plants collected from flowers by honey BEES, and put by them into the cells of honey comb. The goodness of honey depends somewhat on the kind of food of the bees, their age, and the weather in which it is made. Very sweet flowers give it a pleasant smell and taste, while some give it not only a bad taste, but even make it unsafe to eat. But honey which is poisonous to man does not injure bees, and so they make it out of almost all kinds of flowers.

Honey is made up of grape SUGAR, wax, gum, and some other things. From the most ancient times it has been an article of food, but it is not so much used now as it was before sugar was known. The best honey is the newest, made by young bees, which is a clear fluid in a white comb. This is sometimes called virgin honey. As it grows older honey gets a yellow or reddish color. Honey is used by tobacconists to sweeten tobacco with, and from it is made a fermented (see BEER) drink called honey wine or mead.

The word honey is from the Anglo-Saxon *hunig*, honey.

HOOF, the horny covering on the feet of horses, cows, sheep, goats, etc. The hoofs of animals, especially those of cattle, are used for making common combs, buttons, and handles. The hoofs of horses, which are coarser than those of cows and oxen, are made into glue and ground up for manure. A substance called prussiate of potash, used in making Prussian blue for dyeing and calico printing, is also made from hoofs.

The word hoof is from the Anglo-Saxon *hof*, hoof.

HOOK and **EYE.** These are made out of brass wire by machines very like those which make PINS. One machine makes hooks and another eyes, and each can make about 200 every minute. The wire, which is wound around a roller, is drawn in by nippers, cut off into just the right length for a hook or an eye, as the case may be, flattened, and bent into shape, all by the action of machinery. All the man who attends to the machines has to do, is

to see that they have plenty of wire. Each hook or eye, as soon as it is finished, drops into a box and makes room for another. They are silvered or tinned afterward in the same way as pins. Some hooks and eyes are made of iron, and blackened with japan varnish.

The word hook is from the Anglo-Saxon *hoc*, hook; eye is from the Anglo-Saxon *eage*, the eye with which we see, and is so named on account of its shape.

HOPS, the flowers of the hop plant, a vine which grows two or three times as high as a man. The hop grows wild in the cool parts of Europe and in the western parts of Asia, but it was not much cultivated on the continent of Europe until the fourteenth century, and not in England before the reign of Henry VIII. The vines are cultivated in large fields in groups of three or four, around tall poles, up which they climb. The flowers are picked when ripe, dried on hair screens in kilns, and packed in large bags or bales. Hops are used principally in making BEER. They give to it its bitter taste, make it bright and clear, and help to keep it from souring. In the United States hops are grown chiefly in the States of New York, Washington, California, Oregon, and Wisconsin. In 1889 New York produced more than half of the entire crop.

The word hop is in Danish *hop*, and in German *hopfen*.

HORN. Horn is different from bone. The antlers of the stag are bone, and not horn, and they ought not to be called horns. Horn is made up of coagulated, or thickened ALBUMEN, GELATINE, and phosphate of LIME. There is just enough of the lime in it to make it hard without being too brittle; and just enough of gelatine to make it easy to cut and mould when heated.

The horns most used in manufactures are those of the ox, cow, bison, buffalo, sheep, goat, and antelope. Most horns have a bony core, which is got out by soaking them in water five or six weeks. This core is ground up and made into little crucibles called "cupels," used for melting gold and silver in. The tips of the horns, which are solid, are then sawn off, to be used in making knife handles, buttons, etc. The remainder, or hollow part, is easily softened by soaking it in boiling water for half an hour, when it is slit open with a knife, spread out flat and pressed between iron plates. If the "flats," as they are called, are pressed very hard, they can easily be separated into several thin plates, which are scraped and smoothed and sometimes put into lanterns instead of glass. In old times horn plates were used for window-glass. For making COMBS and other things horn is pressed but little, as too much pressure makes the teeth split. It is easily colored so as to look like tortoise-shell, and sometimes can scarcely be told from it.

Horn when heated may be moulded into almost any shape, which it will keep when cold. In making knife and fork handles, buttons, and other small things, the pieces are cut of the right size, softened in hot water, and then screwed up in moulds, which shape the horn, and press upon it any letters or figures that may be on the inside of the moulds. In about twenty minutes the horn is taken out and is then ready to be polished, which is done with ROTTEN-STONE and oil. Even the parings, scrapings, and other little pieces of horn may be softened and pressed into different forms.

The word horn is Anglo-Saxon, and comes from the Latin *cornu*, horn.

HORN, a wind musical instrument, used in ORCHESTRAS and military bands. It gets its name from the fact that the first horns were made from the horns of animals. The kind now used most is called the French horn. This, which is

usually made of brass, is a tube, nearly twice as long as a man, coiled up in several rings, so as to be easier to handle, and having a large bell-shaped end. It is blown through a cup-shaped mouth-piece, and the right sounds are made partly by the lips, partly by the breath, and partly by putting the hand into the large end. The Sax-horn is a much improved kind of horn, first made by Sax of Paris. It is the one generally used in orchestras.

The cornet-à-pistons (horn with pistons) is a small kind of horn, fitted with valves and pistons so that quick music can be played on it. It makes sweet sounds, but its notes are not so noble as those of the horn, nor so deep as those of the trumpet. It is much used, however, in orchestras, often as a solo instrument.

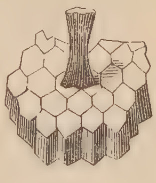
HORNBLENDE, a common rock, sometimes found by itself and sometimes mixed with other stones. It is of all colors, from white through different shades of green to black, but usually only the very dark green or black kind is called by this name. It is sometimes found in GRANITE instead of MICA, and then the granite is called syenite. Hornblende is made up mostly of silica (see SILICON), united with MAGNESIA, lime, or iron.

The word hornblende is from HORN and the German *blende*, blinding or dazzling, and the rock is so called because it splits like horn and shines.

HORNED FROG or **HORNED TOAD,** a kind of lizard found in the Southwestern United States, and in California, Oregon, and Mexico. There are several kinds, of which the best known is about 4½ inches long. It is dusky gray above, with black bars and spots, and white below. Its head, body, and tail are covered with scales, knobs, and sharp spines. Horned frogs are plentiful in Texas, whence they are often brought away as curiosities. They live on insects, and in their native state are very active in pursuing them, but in confinement they grow sluggish and will rarely take food. They spend the winter in holes in a state of lethargy. In October, when they generally seek a place of rest for the winter, they often annoy travellers in the West by creeping into the folds of their blankets, their spines making them uncomfortable bedfellows.

The horned frog is a REPTILE of the lizard order.

HORNET. The hornet belongs to the same family with the WASP, but is larger and stronger. It builds its nest on the branch of a tree, out of a kind of brown paper which it makes from bits of wood and bark. It makes the paper in much the same way as human paper-makers do, by first turning the wood into pulp and then spreading it out in thin layers to dry. The outer wall of the nest is made of many layers of paper, and the cells inside, which are like the cells in honey-comb, are made in separate floors, with the mouth downward, and hung one under another by strong rods of paper. A part of one of these floors with the rod which fastens it to the floor above it, is shown in the picture. The hornet lives on fruits, honey, and insects, especially flies. It does not make honey itself, but steals it from honey bees. Hornets live in societies made up of males, females, and workers, like bees. The females and the workers, which do all the work, are armed with sharp stings, and they fiercely attack and sting anyone who disturbs their nest, making a painful wound.



Part of Hornet's Nest.

The hornet belongs to the order *hymenoptera*, or membrane-winged INSECTS.

The word hornet is from the Anglo-Saxon *hyrnet*.

HORSE. The horse is thought to have been first tamed in Central Asia. The ASS, which is hardier and lives on cheaper food, was used before it as a beast of burden and for riding; and even after the horse was tamed, it was for a long time ridden in the East only in war. The Assyrians and the Egyptians both drove and rode horses at a very early date. The Scythians, who probably learned the use of the animal from the Egyptians, were among the earliest horsemen, and it was from them that the Greeks first heard of the horse. When the Greeks first saw mounted Scythians they were struck with fear, for they thought that the horse and his rider were one animal; and from this probably grew the story of the Centaurs.

The horse is one of the most intelligent of animals. Its senses of hearing and of smell are strong, its sight is excellent, and it can see by night much better than a man. It has a very strong memory and easily finds again a road which it has once travelled over or a place it has once visited. It knows its master well, and if kindly treated will always do its work willingly and cheerfully. Indeed, it often takes as much pride and pleasure in its work as the one who drives or rides it; the racer knows its business and strives to win, the hunter follows the hounds with the greatest zeal, and the warhorse rejoices in the sound of the bugle and of military music. Horses can be trained also to do many wonderful things, and some in circuses perform feats which seem to require much thought and judgment.

The horse sometimes lives to be thirty years old, but it is seldom of use for more than fifteen or sixteen years. The male horse is called a stallion, the female a mare; the young when first born is called a foal, and afterward a colt; and the female colt is usually called a filly. Colts are commonly broken to harness when three years old.

Home of the Horse. There were no horses in America when it was discovered by white men, and all now in either North or South America are descended from horses brought from the Old World. But America was one of the original homes of the horse, and in the early ages of the world horses of several kinds were abundant here and roamed in countless numbers over the great plains of the West, especially of the Rocky Mountain region. We know this from their bones, which are found in immense quantities in the basins of the lakes which covered that country ages ago, and which are now called the "bad-lands." Some of these ancient horses were no larger than a fox, some were about the size of a sheep, some as large as an ass, and some as large as and even larger than the modern horse. What is more remarkable, the smallest kind had four toes before and three toes behind; the next three toes on all its feet; the third one large toe and two smaller ones; while the last had but one toe, much like the horse of to-day. These differently formed horses did not all live at one time, but in several geologic periods or ages of the world. They extended over parts of North and South America at the same time with the mastodon and other great animals now known only by their bones.

Wild Horses. When the Indians first saw the Spaniards mounted upon horses they were as much afraid of them as the ancient Greeks had been of the Scythians. There are now many wild horses in South America and in the southwestern parts of North America, all descendants of horses brought from Europe by the Spaniards and other early colonists. In South America these wild horses live in herds of many thousands each, on the plains called *pampas*. Each herd is under the command of an old stallion, who has

won the right to lead by his strength and courage, and who heads the herd in all its wanderings in search of the best pasturage. When he fails another one takes his place, so that the herd is never without a leader. If wild horses fall in with tame horses the latter at once join the herd, and soon become as wild as the others. During the dry season they travel toward the rivers for water, and many are often trampled to death at the drinking places. Wolves and other wild beasts sometimes attack them, but the horses form a circle with their heels outward and drive them off with kicks, and only the sick and weak ones are killed.

Wild horses can be tamed and made useful to man, but it is very hard work to subdue them. The Spaniards and Indians take them by surrounding a herd and driving them into a large yard called a *corral*, where they are caught one by one and ridden until they are tired out. Their spirits are thus broken, and they do not afterward try to escape. They are caught in the corral with either the *lasso* or the *bolas*. The lasso is a long rope made of plaited hide, with an iron ring on one end, through which the other end is drawn so as to make a slip-noose. When a horse is wanted a man rides into the corral on a steady horse, carrying a lasso coiled up in his left hand, the end of it being fastened to his SADDLE-girth. He then takes the slip-noose end in his right hand, with about twelve feet of the lasso, swings it round his head a few times, and throws it at the horse wanted. The weight of the iron ring carries the lasso out its full length, and the slip-noose falls over the horse's head and catches it by the neck, when the horseman draws it out of the corral. The South Americans who live on the great plains use the lasso so well that they can easily catch a horse running at full speed either around the neck or the legs. The lasso is also much used in Mexico and Texas to catch the wild horses and cattle of those countries.

In the southern part of South America the bolas is more used than the lasso. The bolas is made of two balls, usually of lead, covered with leather and joined together by a plaited rope six to eight feet long. The horseman holds one of the balls in his right hand and whirls the other round his head. When it is going fast enough he suddenly lets go, and the bolas shoots through the air and winds round the legs of the horse he is chasing, so that it is at once stopped and generally thrown down. The horseman then jumps off of his own horse, wraps his cloak round the wild horse's head, so that it cannot see, puts a bit into its mouth, mounts it, and rides it until it is tired out.

The wild horses of South America are called in that country *parameros*, but those of Mexico are called *mustangs*. There are also wild horses in Tartary called *tarpans*, whose habits are much the same as those in America, and a few wild ones are found in Northern Africa.

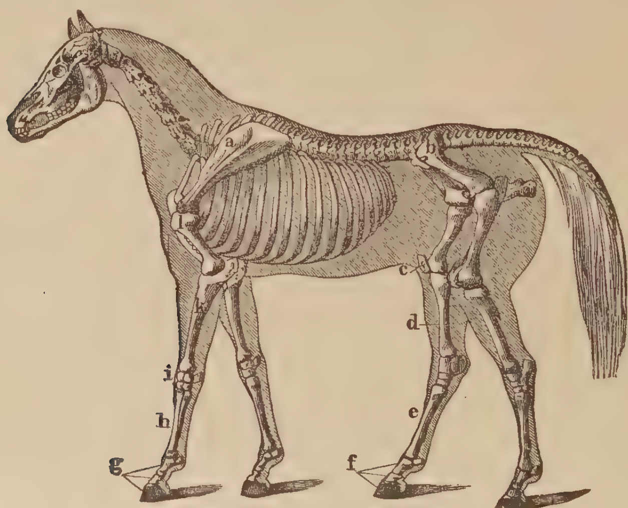
Parts of the Horse. Every child should know how a horse is made, for this noble animal, at once the companion and servant of man, cannot be well understood without a knowledge of its parts. Something of this can be learned from the picture, in which both the skeleton and the outer parts are shown. The skeleton is made up of: the bones of the head; the vertebral column or spine (see ANIMAL), made up of many small bones jointed together, reaching from the head down through the neck and across the back to the end of the tail; the ribs; the shoulder-blade and the haunch; and the bones which form the legs. In the picture the letters refer to the bones of the skeleton and the figures to the outer parts of the horse.

In the head can be seen the way the teeth grow, the cutting teeth be-

ing in front, and the grinding or chewing teeth behind, with a space between them where there are no teeth. This space, called the bar, is very useful, for in it the bit is put, and the horse can thus shut its mouth with the bit in it. The cutting teeth are twelve in number, six in each jaw, and there are six grinding teeth on each side in both jaws. The second teeth begin to come between the second and third year. The age of a horse can be told by the marks in its teeth, which change a little every year until the animal is about nine years old, but after it gets beyond that age, it is hard to tell certainly how old it is.

The principal parts of the body of the horse are: 1, the chest; 2, the withers, or place where the shoulders meet above; 3, the barrel, or part of the body shut in by the ribs; 4, the flanks; 5, the loins; and 6, the buttocks. The tail is made up of two parts, the bone and flesh part called the dock, and the hair.

Of the bones, *a* is the shoulder-



Skeleton of the Horse.

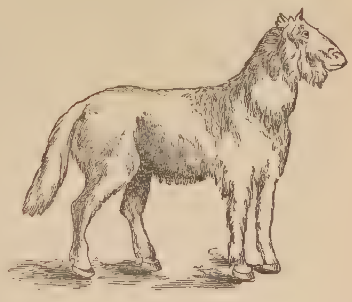
blade, and *b* the haunch or hip-bone. In the forelegs, *l*, which is the same as the upper arm bone in man, is called the humerus; and *k*, which is the same as the bone of the forearm in man, is the radius; the joint between the two is the elbow. The joint *i*, below the humerus, is the knee, and the part *h*, below the knee, the shank. The parts marked *g* make up the fore pastern and the foot. The hind legs are each made up of the thigh *t*; the stifle-joint *c*; the leg-bone or shin-bone *d*; the hock *s*; the metatarsal bone, or bone between the ankle and the foot; and *f* the hind pastern and foot. From this it will be seen that the part of the foreleg from the knee, *i*, down to the end of the foot is the same as the wrist and hand in the skeleton of man, and the part of the hind leg from the hock *s* to the end of the foot is the same as the ankle and foot of man.

The horse has but one toe on each foot, but in the early ages of the world, before the time of man, there were horses both in Europe and America which had several toes,

Colors of the Horse. Horses are of several colors, all of which have names given to them. A bay horse is reddish-brown; dark bay is a dark nut-brown, and light bay a yellowish-red. A horse is said to be dappled bay when it has spots on the rump darker than on the rest of the body. All bay horses have black manes and tail, and dark ones usually have the legs below the knees and hochs black. Some horses are of so dark a brown as to be nearly black, but the real black horse is almost coal black. A chestnut horse is a light red or cinnamon-colored bay, but some are darker. Some chestnut horses have white or yellowish-white manes and tails, and others have black ones. The roan horse is a mixture of red and white or black and white in spots; when the colors are in patches, the horse is said to be pied or piebald. Dun-colored horses are of a yellowish sandy hue with white or black tails. There are several kinds of grays; the silver gray, which is nearly white; the iron gray, which has more black hairs than white; and the dappled gray, which is marked with spots and blotches of black or dark gray. A horse with small black spots on white or gray is called flea-bitten.

Gaits of the Horse. The horse has many gaits: it walks, trots, gallops, and ambles or paces. When a horse walks it appears to move one forefoot and one hind foot on different sides together, and then the other two, but it really moves only one foot at a time. If the left hind leg is first raised, the left forefoot is taken up just before the hind foot touches the ground; the right hind foot is then raised, and then the right forefoot. In trotting the movement is much quicker, and two legs are moved at once, one on one side and one on the other. In the gallop, the two front legs are moved nearly at the same time, and the two hind ones are then brought up quickly and nearly together. The canter is a slow kind of gallop which is taught the horse. In the amble or pace two legs on the same side are moved together, and then the two on the other side. Wild horses only trot and gallop, and these are the only gaits known to the Arabian horse.

Breeds of Horses. Almost every country has its own breed of horses, suited to the climate and to the wants of its people. The horses of cold and bleak countries are small and rough-haired, and they have thicker skins than those of warm climates, which are larger and sleeker. The horses of Iceland are small, with thick shaggy hair. They are nearly wild, being allowed by their masters to feed on the mountains where they please, and are caught only when they are wanted. The wild tarpans of Tartary are not much larger than



Tarpan of Tartary.

common mules, and in the winter their hair is so long and thick that it feels like a bear's fur. They are generally yellowish brown, though a few are black or white. They have a large head with long hair hanging from the lower jaw like a goat. Herds of these horses are often caught in snowstorms along the north shores of the Black Sea, and losing their way rush out on the ice, where many break through and are drowned.

The **Arabian Horse** is one of the finest of all horses. For hundreds of years it has been bred with the greatest care, and the Arab takes as

much pains to preserve the history of his horse as noble families do that of their children. He brings it up, too, as one of his family, sharing his tent with it and feeding it from his own hand. He often sleeps with his head pillowed upon its neck, and his children make a pet of it, and roll about upon it when lying down without getting hurt. As soon as a colt's back gets strong enough it is taught to carry a boy. Afterward, as it grows larger, it is made to carry a heavier boy, and then a youth, its burden being thus added to, little by little, until at last it is able to bear the weight of a full grown man. The Arab always rides a mare, because she does not neigh as a horse does when coming near other horses, and he can, therefore, ride near the homes of his enemies in the night without being found out. He will often sell a horse, but it is very seldom that he will sell his mare. He may be ragged and hungry, but he will part with his life sooner than with what is as dear to him as one of his children. A story is told of an old Arab who had a valuable mare which had carried him for fifteen years in many a march and battle. At length, when he was eighty years old, he gave her, with a sword, which had been his father's, to his eldest son, and told him never to lie down to rest at night until he had rubbed them both as smooth as a looking-glass. In the first fight in which the son rode the mare he was killed, and the mare fell into the hands of the enemy. When the old man heard the news, he said that life was not worth preserving, for he had lost both his son and his mare and he died in a few days.

The **Barb** or **Barbary Horse** of Northern Africa is much like the Arabian, but is smaller, and has less spirit and speed. The Moors carried many of these horses into Spain, and from them are descended the Andalusian horse called the jennet, and other breeds of horses in Spain. In old times Spanish horses were better than they are now, and were much prized everywhere for saddle horses, one kind being the favorite war-horse of knights.

The **English Horse,** from which the best horses in the United States have come, has much Arabian and Barb blood in it. The race-horse is swifter for short distances than the best Arabian horse. It is much like the Arabian in looks, but is taller and longer, and has changed in color. The Arabian horse is generally white, light gray, or flea-bitten, but the race-horse is more usually bay and chestnut. The changes have probably come from the difference in the climate and in the way the horses are brought up. The American race-horse is descended from the English race-horse, and is, therefore, also of Arabian blood. The fastest mile ever run by a race-horse in the United States up to 1892 was made by the horse named Kildeer, in one minute and thirty-seven and one-quarter (1 : 37¼) seconds.

The **Trotting Horse** of the United States and Canada is the fastest in the world. It is not a thoroughbred horse, or a horse of pure racing blood, like the race-horse, but is generally a descendant of a cross between the race-horse and some common breed; but a few thoroughbred racing horses have been taught to trot very fast. It is not usually so tall as the running horse, and is sometimes small. There is a good breed of trotting horses in Russia, called the Orloff trotter, which is faster than common horses, but not so fast as the American trotter. The fastest mile ever trotted in the United States up to 1892 was made by the mare Nancy Hanks in two minutes and four seconds (2:04).

Draught Horses, or horses used for drawing heavy loads, are raised in many countries. In France the Percheron breed has been noted for hundreds of years. Many of them

are to be seen in Paris, where they are much used for drawing omnibuses and business wagons, and some of them are used in the United States. They are large, heavy horses, with large heads. In England the breeds called the Suffolk, the Cleveland Bay, and the Clydesdale are noted for their size and strength. The Flanders horse, of Belgium and Holland, is very large, heavy, and strong. Many of the great horses used by brewers in London and Paris are of this breed.

All these breeds are called heavy draught horses, because they are used in the heaviest kinds of trucks and large wagons. There are also light draught horses, for drawing lighter loads, which are not quite so heavy in the body and are quicker in their motions. The carriage horse is of a lighter and more elegant form than the common draught horse, but is generally large and strong. The saddle horse should be a little smaller than the carriage horse, and should be graceful and active in all its movements. It should be taught not only to obey the rein, but to understand every motion of its rider.

Ponies are found in many countries. Among the most noted are the Shetland ponies, raised in the islands of the same name, north of Scotland, where they are called Shelties. Some of these little horses are not much larger than a great dog, but they are very strong, and will carry a man with ease. The Indians of the western parts of the United States have a breed of ponies which are very hardy and strong. One of them will travel all day long with a heavy man on its back.

Uses. The horse is useful to man not only during life, but is very valuable also after death. Its flesh is sold in Europe as food for dogs and cats, and in some countries it is used as food for man. On the great steppes of Asia wild horses are hunted for their hides and their flesh, which has been eaten from the earliest times. In Tartary, where the chief wealth of many tribes of people is in their horses, the milk of mares is used as we use cows' milk, and a kind of strong drink called *koumiss* is made from it. The hide of the horse is made into leather for gloves and for covering office chairs and sofas, and the hair of its mane and tail is used for stuffing mattresses, saddles, and horse collars, and for making hair-cloth, sieves, fishing-lines, and the bows of violins. Its bones are made into buttons, ground for manure, and burned for BONE black; its hoofs are boiled for glue, and its intestines are used for many purposes.

The horse is a MAMMAL of the order *pachydermata*, or thick-skinned animals, and belongs to a family which includes also the ass and the zebra.

Our word horse comes from the Anglo-Saxon *hors*, horse.

HORSE-CHESTNUT, a handsome tree, raised chiefly for ornament, as its wood is soft and not worth much. It bears large spikes of showy white flowers, and a fruit or nut covered with a thick prickly shell which splits into three parts before it falls. The nuts are bitter, and though cattle, horses, sheep, and swine will eat them, they are not fit for food for man; but in France they have a way of taking the bitter taste out of them, and they then make them into a kind of meal which is much eaten by common people. The bark of the tree is sometimes used in tanning leather, and the rind of the seeds and the outer husk have been employed in dyeing. A kind of horse-chestnut which grows in the Western States is called the buckeye.

The horse-chestnut is so called because it used to be ground into meal and fed to horses.

HORSERADISH, a plant cultivated for the sake of its roots, which is used on the table as a seasoning for meats. The root is grated and put up in bottles with vinegar. It

has a sharp biting taste, which comes from a kind of oil in it, much like the oil in mustard seed.

Horseradish came first probably from eastern Europe, where it grows wild. It is called in English horse-radish on account of its strength. In Germany and in Holland it is called sea-radish because it grows best near the sea. The Swedes call it *peppar-rot*, pepper-root.

HORSESHOE. Horseshoes were once always made by hand, and still are in many country places by blacksmiths, who hammer them into shape upon anvils; but most of them are now made by machinery. A bar of iron of the right size is heated red-hot, and put into the machine between two rollers. The machine cuts off enough for one shoe, bends it round, stamps it with DIES, which give it shape and make the groove around it for the nail heads, and drops it out all ready for the nail holes, which are punched in it by hand. Each machine will make about sixty horseshoes every minute.

HORSESHOE CRAB, or **KING CRAB.** This animal gets its first name from its shape and its second name from its size. It is usually called horseshoe or horsefoot crab in this country, but in the East India Islands, where it grows to be two or three feet broad, it is called king crab. The common horseshoe crab is found all along the Atlantic coast of the New England and the Middle States, and its cast off shells are often seen on the sands. The shell is in two parts, a rounded piece in front and a nearly three-cornered piece behind, fitted to it by a kind of hinge. To the back end is joined a long sharp tail, the one use of which seems to be to help the crab turn over when it gets on to its back. But the animal uses it also in digging, for it loves to burrow out of sight into the mud and sand. In doing this, it bends down forward the sharp front piece of its shell, bending down backward the other piece so as to push against the ground with its tail, while its feet throw out the dirt on both sides. It can thus soon force its body under the sand. In the East Indies the Malays point their spears with these sharp tails.

The mouth of a horseshoe crab is in the middle of its under part, between its legs, which grow out all round it. The parts of several of the first pairs of legs are fitted with rough points with which the crab grinds up its food before it swallows it; so its teeth are really on its legs. It has two large eyes on top of its shell, and two others in front, so it can see all around.

Horseshoe crabs are hatched from eggs laid in May or June. When the tide is high, the female scoops a hole in the sand just at the edge of the water, lays her eggs in it, and leaves them to be covered by the sand and hatched by the heat of the sun. When born, the little crab is only about a quarter of an inch wide, and has a shell but no tail. It soon outgrows its shell, which splits open in front and lets it out. A new and larger shell grows in place of the old one, and this one has a little sharp tail. So it goes on, as long as it lives, spliting open its old shell in front, creeping out, and getting new ones.

The horseshoe crab is a CRUSTACEAN of the order *dekapoda*, or ten-footed ANIMALS. Lobsters, other crabs, crawfish, and shrimps belong to the same order.

HOUR-GLASS, an instrument for measuring time. It is made of glass and has two parts joined together by a narrow neck; one of the parts is filled with dry sand, of which there is just enough to run through the neck in an hour. When all the sand has run through, it may be turned over and the sand allowed to run the other way. It does not keep good time, because in hot weather the glass swells, so that the neck is larger than in cold

weather, and the sand is not always of the same dryness. There are also half-hour glasses and minute glasses; and some are made to run just three minutes and are often called egg glasses, because they are used to time the boiling of eggs. Mercury is sometimes used in them instead of sand.

HOUSE. In building a house the first thing is to get a good foundation, on which it is to stand. Unless a solid foundation is made the house will not stand even a great while, but will be apt to settle in some places more than in others, and this will cause the plastering of the walls to crack, and the doors and windows to sag or lean so that they will not open and shut easily. It is sometimes hard to get a good foundation. The best bottom for one is solid rock or closely packed gravel, and if these are not found on the surface of the ground the earth has to be dug away until a good bottom is reached. Sometimes a solid bottom cannot be got even by digging, and then one has to be made. This may be done in many ways: sometimes heavy planks or beams of wood are laid down, sometimes a thick layer of concrete, or broken stones and CEMENT, is spread over the bottom, and sometimes it is necessary to drive PILES down until they reach firm ground. When the piles are driven, the tops are afterward cut off even, and the bed thus made is covered with a platform or flooring of planks, on which the stone wall is built.

Masonry. After the foundation, the next thing is the masonry, or the making of the wall on which the building is to rest. The masonry may be of either stone or brick, or of both stone and brick. The wall under a building is usually built of better and more regular stones on the outside than on the inside, especially in that part of it which is above the ground. The outside of such a wall is called the face, shown in *a*, Fig. 1; the inside, the backing, shown in *b*; and the middle part, or part between the face and the backing, which is usually filled in with small stones as in *c*, the filling.

Each layer of stone or brick in a wall is called a course. The lower course, which rests on the foundation, and which is usually wider than the courses above it, is called the footing, and the top course, which is made up of longer and better stones than the other courses, is called the coping. In the picture, Fig. 2, a part of the coping is shown in *c*. Stones in which the long sides are laid lengthwise in a course, as in *aa*, Fig. 2, are called stretchers, and those whose long sides are laid across a wall so as to bind it together, as in *bb*, are called headers or bond stones. The cracks between the stones are called joints, and masonry is always so laid that no up and down joint shall run across two courses, but that each one shall come between the two in the course next below. Walls may be laid with or without MORTAR. When without mortar, the work is called dry masonry. Masonry of rough stones laid dry is called rough wall, and when laid in mortar, rubble work: but sometimes all rough work is called rubble work. Masonry of

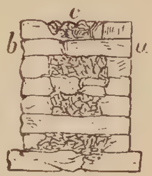


Fig. 1.—End of Foundation Wall.

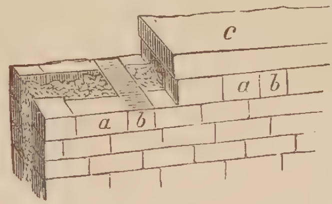


Fig. 2.—Side of Foundation Wall.

cut stone, in which each stone is squared and dressed to fit, is called ashlar masonry. In common cut-work only the face is made ashlar and the backing of rubble or brick.

If the house is to be of stone or of brick the walls are built up to the roof, the parts above being much narrower than the foundation walls,

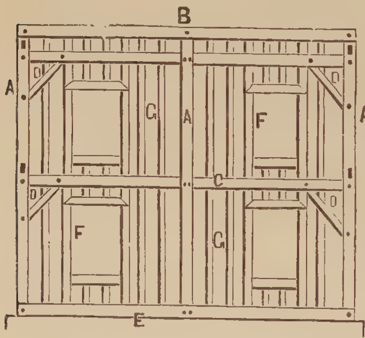


Fig. 3.—Wooden House Frame.

and holes being left in the proper places for the floor-beams; but if it is to be of wood the wall is carried up only a little way above the surface of the ground. In building a wooden house, the next thing to do after the foundation wall is done is to put up the frame. Heavy beams called sills are first laid on top of the foundation walls, and then the joists, or thin beams on which the lower floor is to be nailed, are fitted on to those; but sometimes the joists are laid across on the wall itself, the spaces between them filled in with stone even with their tops, and the sills then laid on them.

The **Frame** is usually fitted together on the ground, fastened with wooden pins, and then raised, one side at a time, and set into holes made for its different parts in the sills. The parts of a frame may be understood from the picture, Fig. 3, which shows one side of the frame of a house. In this the beams marked A A A are the posts; E is the sill; B is the plate or wall-plate; C is one of the girts; D D are braces; F F are the window-posts or window-studs; and G G are studs. The joists for the upper floors are fitted on to the girts. When floors are so large that it is not safe to use single joists, a large beam, called a girder, is put across the middle, and the ends of the joists are fitted into it on each side. The floor boards are nailed on to the upper side of the joists, and LATHS are nailed on to the under side to hold the plaster of the ceiling of the room below. Partitions are made by setting up studs the right distance apart for the laths.

Roofs are made in many different ways. In cities brick and stone buildings often have flat or nearly flat roofs, but in the country, roofs are usually made slanting, so as to carry off the rain and snow easily. A simple kind of frame for a roof is shown in the picture Fig. 4. In this, B B are the ends of the two wall-plates, the side of one of which is shown in Fig. 3. The beam T,

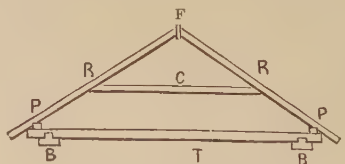


Fig. 4.—Collar Roof Frame.

which is fastened on to the plates by notches, is called the tie-beam, so called because it ties the walls together, and keeps them from being pushed out by the weight of the roof. On top of the tie-beam, at the ends, are laid smaller beams called pole-plates, P P, on which are fastened, by notches, the rafters, R R. To keep the rafters from spreading, a small tie-beam called a collar, C, is fastened on to the rafters, which are also held together at the top by a thin beam, F, called the ridge-pole.

Another kind of common frame for a roof is shown in Fig. 5. In this the parts marked with the same

letters are the same as in Fig. 4; but instead of a collar a piece called a king-post, K, is put in between the tie-beam and the top of the rafters,

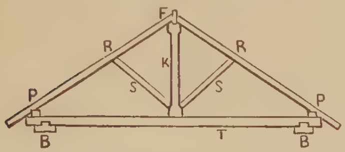


Fig. 5.—King-post Roof Frame.

and two other pieces, called braces or struts, S S, are placed so as to brace the rafters. Such a roof frame is called a king truss. Still another kind of frame, called a queen truss, has two posts set up between the tie-beam and the rafters, one on each side, instead of a single one in the middle.

On the outside of the rafters rough boards called "battens" are nailed, and on these are nailed the shingles, slates, or tiles, which form the outer covering of the roof. The chimneys are usually built before the roof is finished, so that the parts of the roof

Fig. 6.
Pent Roof.

Fig. 7.
Gable Roof.

around them may be made tight. Roofs are of many different shapes on the outside, several of which are shown in the pictures. Fig. 6 is called a pent roof, from the French word *pente*, which means slope. It is sometimes also called a shed roof,

Fig. 8.
M Roof.

Fig. 9.
Hip Roof.

because used for covering sheds. In New England a shed with such a roof is often seen built on the back of old houses, and is there called a "lean-to," because the rafters lean against the main building.

The gable roof, so called because its two ends form gables pointed like a triangle, is shown in Fig. 7. This is the most common kind of roof. A roof with double gables, as in Fig. 8, is called an M roof, from the shape of its ends, Such a roof is oftener seen on barns than on houses. A roof in which the points of the gables are cut off, so that it slants on all four sides, as in Fig. 9, is called a hip roof. A curb roof, Fig. 10, is so made that another story is formed above the wall-plates. This roof is commonly called

Fig. 10.
Curb Roof.

Fig. 11.
Ogee Roof.

the Mansard roof, after a French architect of that name, who often put it on houses which he built. It is now often built on villas and handsome country houses. The ogee roof, Fig. 11, is not much used, excepting on pavilions, summer-houses, etc.

The **Sides** of the house are usually first covered with rough boards nailed on diagonally or cornerwise, and the CLAPBOARDS are then nailed on to these; but in the best houses, layers of felt, paper, or some other water-proof material are put on between the rough boards and the clapboards. Doors, window-frames, and blinds are usually made at factories.

In many places, when a new house is to be built, the neighbors gather together to aid in raising the frame. At such a gathering, which is called a "house-raising," there is usually much merriment, and after the frame is up, and the wooden pins which hold it have been driven in, refreshments are served by the owner. It is also customary in Germany, and

in some places in England and in this country, to fasten a green bush or small tree to the gable.

The word house is from the Anglo-Saxon *hus*, house.

HUCKLEBERRY, HURTLEBERRY, or **WHORTLEBERRY,** the fruit of a shrub of the heath family. Huckleberry bushes grow wild almost all over the United States, and great quantities of the berries are picked by women and children for market. There are several kinds, among which are the black huckleberry, called crackers in New Jersey, because they have tough skins which crack when broken between the teeth; the dwarf blueberry, seldom more than a foot high; and the swamp blueberry, which grows sometimes higher than a man. The bilberry, called in Scotland blaeberry, is the same as the blueberry.

The word hurtleberry or whortleberry is from the Anglo-Saxon *heortberie*, hartberry, from *heort*, hart or stag, and *berie*, berry. Huckleberry, which has been changed from the other names, is now the most common name for the fruit.

HUMBLE-BEE, or **BUMBLE-BEE,** a kind of bee which gets its name from the humming noise it makes when flying. It is larger than the honey-bee, different in its colors, being usually yellow and black, and hairy both on its legs and body. Humble-bees live in smaller companies than honey-bees, and they do not lay up any honey for food. They are divided into three kinds: workers, which are the smallest; males, which are larger; and females, which are larger than the males.

There are usually several females or queens in each nest. The workers and the males die late in the autumn, but the queens creep under moss or leaves, or into some old nest, and lie there in a numb state through the winter. In the spring they awaken from their long sleep, and each one may be seen looking round for some hole or crevice in the ground where she may make her nest. As soon as a queen finds a place to suit, she collects some pollen and honey from FLOWERS, puts it in the nest, and lays in it seven to fourteen eggs. She keeps adding to the mass of pollen until the young are hatched from the eggs. The young or larvæ live on the pollen, and as soon as they are of full size they spin silk around themselves; the old bees cover this with a thin coat of wax, which makes it into a tough cell. The larvæ change into pupæ (see INSECTS) and stay in these cells until they turn into humble-bees, when they eat their way out. and become mostly workers. No male bees are hatched until late in the summer. The cocoons are afterward used for laying up honey, on which the colony feeds during the summer. Foxes, rats, and other small animals know well how to find these honey cells, and often rob the humble-bees of their store. Humble-bees will sting, but their sting is not so bad as that of the honey-bee or the wasp.

The humble-bee belongs to the order *hymenoptera*, or membrane-winged INSECTS.

The name of this bee is either humble-bee or bumble-bee; bumble is old English, and means to make a humming noise.

HUMMING-BIRD, a bird so called from the sound made by its wings. Humming-birds are found only in America, though the sun birds of the Old World are much like them in many things. There are more than three hundred kinds, most of which live only in Central and South America, and in the West India Islands. Humming-birds are the smallest and most beautiful of all birds. Some of them, when stripped of their feathers, are not much larger than humble-bees. The different kinds have many different forms of plumage, different in crests, neck feathers, leg feathers, wings, and

tails, and their colors show all the tints of the rainbow. The muscles of their wings are stronger for the size of their bodies than those of any other birds; this makes them able to fly with great swiftness and to hover over a flower while they sip the honey or catch the insects in it. Their bills are slender and mostly very long, being straight in some kinds and curved in others, according to the kinds of flowers they live on. Their tongue also is very long and can be darted out to a considerable length.

Humming-birds do not sing, but have only a kind of shrill cry. They build very pretty nests of mosses and lichens, lining them with cotton or any other soft thing which they can find, and lay two white eggs about as large as peas. The humming-birds of the north go south in winter, and return in May. They are easily tamed and will come to the window to be fed, but cannot be kept in cages, for they cannot bear to be shut up, and usually die in two or three months.

Humming-birds are admired by everybody for their beauty, and many pretty names are given to them. The Indians in South America call them "sunbeams," the Brazilians "flower suckers," and white people in other parts of South America, "flower-peckers." In the West Indies they are often called "murmurers," from the sound of their wings. In some places they are much hunted for their beautiful feathers, from which ladies make collars and many kinds of ornaments; their wings and tails, and sometimes whole birds stuffed, are used to decorate ladies' hats. The ancient Mexicans and Peruvians used to trim mantles with their feathers, and also weave them into beautiful pictures, and Christian Indians in South America ornament the images of their saints with them.

The humming-bird belongs to the order *insessores*, or perching BIRDS.

HYDROGEN, one of the principal ELEMENTS. In its usual form hydrogen is a gas without color or taste, and when pure without smell; but it may be changed into a liquid by a great amount of cold and of pressure. It is the lightest of all known substances, being nearly fifteen times lighter than common air, and more than 150,000 times lighter than quicksilver. BALLOONS therefore are often filled with it.

Water is made up of hydrogen and OXYGEN, there being in it two parts of hydrogen to one part of oxygen; but as oxygen is sixteen times as heavy as hydrogen, there are eight times as much of it by weight in water as there is of hydrogen; or, in other words, there are eight pounds of oxygen and one of hydrogen in every nine pounds of water. Hydrogen is never found alone by itself, and when we want some we have to get it out of water.

Whenever hydrogen is burned, whether pure, or mixed with other things, water is always made. As the flame is very hot, the water is always in the form of a gas, so that we cannot see it, but it can be easily turned to a liquid by cooling it. If a cold bottle be held over a flame of burning hydrogen, the inside of it will become covered with dampness and water will soon run down in drops. Though burning hydrogen gives but little light, its flame is one of the hottest known, and it is used with oxygen in the oxy-hydrogen BLOWPIPE to melt very hard things. It is also used with oxygen and lime to make the CALCIUM or Drummond light, which is one of the brightest known.

Some people think that everything in the world is made of hydrogen, and that all the elements are only hydrogen in different forms, but this is not probable.

The word hydrogen means water-maker, and it is made from the Greek words *udor*, water, and *gennein*, to make.

HYENA. This animal is found wild only in Africa and in Southern Asia. It is generally a little taller than a large dog, but some are much larger. Its body is covered with coarse shaggy hair, which grows like a mane on the back and neck. Its hinder parts are lower than the fore parts, which gives it an awkward, shambling gait, and it has a large head and ears. It lives chiefly in caves, from which it comes out at night to look for food.

Hyenas are among quadrupeds what vultures are among birds, for they live mostly on decayed animals, and are very useful in clearing cities and villages of rotting things which might make sickness. They often follow armies to eat the dead bodies of the slain, and in the East they sometimes dig up corpses from graveyards. When very hungry they will attack cattle, and they have been known to carry off children, but they are afraid of grown-up men.

The striped hyena, whose coat is yellowish-gray striped with black, is found mostly in Northern Africa, Arabia, Syria, and Persia; and the spotted hyena, which has spots instead of stripes, is found mostly in South Africa. The spotted kind is easily tamed, and some Africans keep it for a dog.

The hyena is a MAMMAL of the order *carnivora*, or flesh-eating animals. By some writers it is put in the dog family, but it is usually put in a family by itself.

The word hyena is from the Latin *hyæna*, hyena.

I

IBIS, a wading bird, with a long curved beak, which feeds principally on reptiles. There are several kinds in different parts of the world. The Egyptian ibis, one of the most sacred birds of ancient Egypt, is about two feet and a half long, though its body is only as large as that of a common fowl. The head, neck, and legs are black, and the body white with a plume of bronze, blue, and green

Scarlet Ibis.

feathers behind. The ibis was thought in Egypt to represent the god Thoth. As it usually appeared at the rise and went away with the fall of the Nile, it was believed to come to deliver the country from serpents and other pests. Ibises were kept in the temples, where they had the best of care, and after death their bodies were mummied and preserved.

The **Scarlet Ibis,** found in the Southern United States, the West Indies, and Central America, was unknown in Europe before the discovery of the New World, but some painters have put it in pictures by mistake for the sacred ibis.

The word ibis is Latin, and is from the Greek *ibis*, said to be of Egyptian origin.

ICE. Water begins to crystallize, or freeze, when the THERMOMETER is 32 degrees above zero, and this is therefore called the freezing point; but on quiet nights, when the water is very still, it will sometimes cool below the freezing point without turning into ice. At such times what is called anchor ice, or ground ice, may be seen on things at the bottom of ponds and streams. This is oftenest seen on clear cold nights when the surface of the water is at the freezing point, and the air is colder. The ice then forms on rocks and other things on the bottom before it forms on the surface of the water. But if water thus cooled below the freezing point be stirred, or anything be thrown into it so as to move it, it will at once freeze and its heat will rise to the freezing point. Different reasons have been given for this, but they cannot be explained here.

In turning into ice, water expands or swells—that is, any given quantity of water makes a larger amount of ice; and the ice is therefore lighter than the water. This is the reason why it floats in water. If it were heavier than water it would sink to the bottom, and all the water become so chilled that in cold countries it would never thaw. When water swells by freezing it causes such a pressure that it splits open rocks, ploughs up the banks of streams, and crumbles the soil. In very cold weather ice shrinks, or be-

comes smaller, so that it sometimes pulls apart in weak places on ponds and lakes with a loud noise like the report of a gun.

Glaciers and Icebergs. In some parts of the earth ice is found all the year round. This is especially the case in the regions around the North and South Poles, and on the tops of very high mountains, even in the hottest countries. In all countries where great tracts are forever covered with snow, the valleys are usually filled with vast bodies of ice which move slowly down toward the bases of the mountains until they reach a point warm enough to melt the ice. These great ice rivers, which are called glaciers (French *glacier*, from *glace*, ice), move so slowly that the eye cannot see them move, but they gain a little every day, being pushed forward by the weight of the masses of snow and ice behind them. In Switzerland glaciers sometimes move down into peopled valleys, and destroy everything, leaving the ground covered with loose stones. The largest glaciers are in the polar regions. In northern Greenland they move down into the sea, where the water breaks off great masses, which float away and become icebergs (German *eisberg*, from *eis*, ice, and *berg*, mountain). The great masses of salt-water ice, caused by the breaking up of the ice-fields in the polar seas, are sometimes also called icebergs, but they are really ice islands. Real icebergs are of fresh-water ice, formed by the breaking off of the ends of glaciers by the sea. Some of them are higher than the highest church steeple, and several miles long. The largest icebergs have been seen in the ocean around the South Pole.

Cutting of Ice. Ice is now used so much all over the world that it has become an important article of commerce. A great deal is shipped to foreign countries every year from the United States, and many men are employed in cutting and storing it up in ice-houses. These houses are built on the banks of the rivers or ponds from which the ice is to be taken. They are great wooden buildings without windows, and are made with double walls with sawdust packed between them, because sawdust is a poor conductor of HEAT, and therefore keeps the outside heat from getting to the ice. When the ice is thick enough to be cut, the top of it is scraped off, if it is soft or if there is snow on it, by a scraper drawn by horses. The surface is then marked off into large squares by a plough, drawn by a horse, and afterward into smaller divisions by a kind of harrow, which cuts grooves or cracks about three inches deep. Some of the blocks are then sawn out by hand, and after an opening has been thus made the other blocks may be easily split off with an ice spade in the grooves. They are then floated along in canals cut through the ice to the bank of the pond or river and hoisted by means of an endless chain worked by a steam engine into the houses, where they are packed in straw, which, like sawdust, keeps the outside heat from it. Ice is sent from the United States to the East Indies, Cuba, and other parts of the West Indies, South America, and other countries.

A good deal of ice is made by art instead of in the natural way. There are two ways of doing this, one in the way in which ice cream is frozen, and the other by means of machines in which a liquid is turned into a vapor. Both of these ways are told about in the article HEAT.

Ice Houses. In some cold countries, like Greenland, people build houses out of ice, and live in them. They are obliged to do this because there are no trees there to build comfortable wooden houses of, and tents covered with the skins of animals would not be warm enough in winter. The ice houses of the Esquimaux are made by piling up square blocks of ice or frozen snow, and

cementing them together by pouring water over them. They are thus frozen into one solid mass. These houses are round, like the half of a hollow ball; a hole is left in the top for the smoke to go out, and a small square of thin clear ice is set into the wall for a window. On the side where the wind blows the least a long passageway is made, so low that one has to crawl through it on hands and knees, and this is the only door. There are two good things about these ice houses: they are so low and so strong that the high winds of that bleak region cannot blow them over, and no one can live in one more than one season, for they melt away in the summer. The Esquimau is very dirty and would never clean a house, no matter how long he lived in it; but the melting of the ice forces him to move, and he lives in a sealskin tent until the coming of cold weather again obliges him to build a new house.

The Esquimaux are not the only people who build ice houses, for a splendid ice palace was once built by an Empress of Russia. This was in the winter of 1739–40, when the cold was very great in Europe. The palace was begun in December, 1739, and lasted until the end of March, 1740. They began to build it on the ice of the River Neva, which flows through the city of St. Petersburg, but the weight was so great that it began to settle, and the workmen were ordered to build it on the banks of the river, near the great Winter Palace. The ice was cut out in great blocks, squared with tools just like building-stone, hoisted into place, and cemented with water which froze at once. The palace was only one story high, and had only three rooms in it, a great hall and two large chambers, one on each side. All the rooms had windows with window-panes of thin ice. The outside of the palace was decorated with ornaments and with statues, all carved in ice. An ice balustrade was built around the front and two ends, forming a kind of courtyard. Outside of this, at the two corners, were large ice pyramids, and between these, in front of the palace, were placed cannons carved out of ice, and great ice dolphins mounted on pedestals. There was also an immense ice elephant, with a man upon his back and other men standing beside him. This elephant had his trunk raised up in the air and spouted water out of it in the daytime and burning naphtha at night, twenty-four feet high. The dolphins, too, were so made that burning naphtha would spout out of their mouths, and the ice cannon could be loaded with real powder and fired. The palace used to be lighted up at night with thousands of candles and torches, and it is said to have looked very splendid; but in these days it can only be regarded as a great waste of time and money.

The word ice is from the Anglo-Saxon *is*, which is from an old word meaning to shine.

IGUANA. See LIZARD.

ICEBERG. See ICE.

INCENSE, a mixture of gums, spices, and other things, burned for its perfume. It is usually a powder made up of benzoin, storax, and other resins, cascarilla bark, etc. Incense is burned generally in Roman Catholic churches in a censer (short for incenser) or thurible (from Latin *thus*, *thuris*, frankincense), a silver vessel hung by chains so that it may be swung in the hand. The powder is so placed that it will drop little by little on a hot plate in the bottom of the censer, and as it burns the smoke escapes through little holes and fills the church with sweet odors. Sometimes incense is made up into little cones called *pastils* (French *pastille*, from Latin *pastillus*, a little loaf), to burn in rooms for perfume.

Some think that incense was first used in churches to make the air sweet, because in old times the com-

mon people were not cleanly in their habits; and others, that it came into use when the plague was raging, to keep people from catching the disease in the churches. But it was used by the ancient Egyptians in their worship, and afterward by the Jews, and it is probable that the early Christians took the custom of burning it from them.

The word incense is from the Latin *incensum*, which is from *incendere*, to burn.

INCH, a measure of length, the twelfth part of a foot. It was originally divided into three parts called barleycorns, because its length was supposed to be equal to three grains of barley placed end to end.

The word inch is from the Anglo-Saxon *ynce*, Latin *uncia*, the twelfth part.

INDIA-RUBBER, the hardened juice of several kinds of trees, growing in Mexico, Central and South America, Africa, and the East Indies. It is also called caoutchouc, and sometimes gum elastic. The India-rubber of commerce comes mostly from the East Indies and from South America, especially from Brazil, but much is brought now from Africa. The East Indian rubber is the juice of a kind of fig tree, which grows to a very great size. The South American is the juice of the syringe tree, which is also very large, being sometimes twice as high as a four-story house; it was so called by the Portuguese because the Indians used little bottles made of the gum to hold water, with which they syringed out their mouths after eating. The trees are tapped by cutting holes through the bark, and the juice is caught in a cup and emptied into a large jar. Moulds made of clay, shaped like shoes, bottles, balls, etc, are then dipped into the juice and dried until the covering is thick enough, when the mould is broken into pieces and poured out. In India the rubber is dried in the sun, and is of a grayish-white color; but in South America it is dried over a fire, and the smoke makes it black. African rubber, brought from Madagascar, Liberia, and Sierra Leone, is often dirty, mixed with bark, stones, etc. The juice is sometimes sent to foreign countries in tin and glass cans. As it comes from the tree it is of a pale yellow, and about as thick as cream; but it hardens and becomes nearly pure white when spread out thin and dried.

Uses of India-Rubber. Until about the beginning of this century India-rubber was used only for rubbing out pencil marks, but now its uses are more numerous than those of almost any other article. All kinds of elastic and water-proof goods are made from it, and it is woven with silk, cotton, or woollen threads into a great number of fabrics. The India-rubber threads are cut in machines. A sheet of rubber is put round a roller, which turns slowly. A little circular knife, which goes round very fast, and which is kept wet with water so that the rubber will not stick to it, cuts a thin thread off the edge of the sheet, and as the roller holding the sheet moves slowly sidewise the sheet is thus cut into one long thread. This thread is then stretched and wound on to another roller. India-rubber loses its elasticity, or springiness, when kept stretched for a few days, and may then be woven with other threads into cloth, elastic bands, suspenders, etc. If it is then passed over a hot roller, it will become elastic again.

In making water-proof clothing the rubber is dissolved, or melted into a liquid, and spread over cloth; the cloth is then pressed between rollers until the rubber is spread evenly over the surface, and is then dried. This makes single water-proof cloth; when two pieces of cloth are thus covered and pressed together between rollers they stick fast to each other and make double water-proof cloth. The rubber used is dissolved or melted usually in gas-tar oil, but

sometimes in turpentine, but the turpentine is apt to smell badly. Rubber will dissolve also in ether, CHLOROFORM, naphtha, and PETROLEUM, but not in ALCOHOL.

Vulcanizing Rubber. The discovery of the art of "vulcanizing" rubber, so called from Vulcan, the god of fire, because it is done by great heat, has largely added to its uses, and made it much more valuable. It is done by mixing it with sulphur and then heating the mixture very hot, when the two unite into one substance which is unlike common rubber in many things. It cannot be dissolved by the things which will dissolve pure rubber; is scarcely eaten by acids, and while more elastic or springy than pure rubber, it keeps its elasticity both in very cold and in very hot weather. Tubes, fire hose, and gas pipes, elastic rings or bands, door and window springs, mats, boots and shoes, machinery belts, and very many other useful things are made out of this kind of vulcanized rubber.

What is called hard rubber or "ebonite" is made out of India-rubber and sulphur heated much hotter than soft vulcanized rubber. This is made into canes, combs, the backs of brushes, buttons, surgical instruments, picture frames, knife handles, and a great variety of other things. Another compound made with rubber, sulphur, and coal tar, heated together, makes a substance which can be cast into moulds or rolled out into sheets, and which, when cold is so hard and black that it looks like JET. This may be cut and polished, and is much used for making articles of jewelry, such as bracelets, breast pins, sleeve buttons, shirt studs, and watch guards, and many other ornamental and useful things.

India-rubber has been known for more than a hundred years, but the many uses to which it is now applied have all been found out during the present century. The discovery of the way of vulcanizing rubber was made by Charles Goodyear, an American, in the year 1839, but it did not come into use until about 1844.

India-rubber gets its name from India, because it was first brought from that country. The word caoutchouc is from *cahuchu*, the South American Indian name of India-rubber.

INDIGO, a blue coloring matter made from several kinds of plants, some of which grow in India and Ceylon, some in China and Japan, some in Egypt, and some in the West Indies and Central and South America. The plants are raised from seed every year. They are cut when green, and soaked in vats of water 15 to 20 hours, when they work and send off much gas, coloring the water light green. The green liquor is then drawn off into another vat, a little lime water is put in, and it is beaten with poles, which causes the green matter to turn blue and settle to the bottom. The clear water is then drawn off, and the blue matter at the bottom is allowed to run into a third vat, where it is permitted to settle again. The clear top water is again drawn off, and the blue matter at the bottom is put into coarse bags to drain. After it has drained enough the paste is put into little boxes and dried in the sun, when it is fit for market. All the best blue dyes are made from indigo, and it is also the basis of the black dyes used for woollen cloths.

A great deal of indigo is raised in West Africa, especially in the valley of the Gambia River. It is grown entirely by women, and is used mostly in dyeing the cotton cloth made on the native looms. In the city of Ibadan, in Yoruba, it is said that nearly the whole population (150,000) is clothed in blue stuffs.

The word indigo is made from the Latin *indicum*, a name given it by the Romans because it came from India.

INK. The ink used by the ancients was more like a paint than like our thin ink, so that the letters were raised a little above the PARCHMENT or papyrus on which they wrote. It was made usually of LAMP-BLACK mixed with gum, and was much like the solid Chinese or Indian ink of the present day. When wanted for use, it was thinned with water. The ancients also made black ink out of the juice of the CUTTLE-FISH. Most of their books were written with black ink, but the title-pages and the heads of chapters were written with red ink, and were therefore called rubrics, from the Latin *rubrica*, red. They also had ink of other colors, and gold and silver inks. Emperors and kings used a purple ink made from the same MOLLUSK which gave the beautiful Tyrian purple, and also a red ink made of vermilion.

Writing Ink is now commonly made of NUT-GALLS, sulphate of iron (commonly called green VITRIOL), gum, and water; but different makers have different ways of making it. If intended for copying-ink, that is, an ink from which a copy of the writing may be taken by pressing a sheet of damp paper on it, a little more gum is put in, and sometimes a little sugar. Blue ink is usually made of Prussian blue, oxalic ACID, and water. The color in red ink is got from BRAZIL WOOD or from COCHINEAL. Indelible or marking ink, used for marking clothes, is usually made of nitrate of silver, mixed with gum arabic, India ink, and water, but there are other kinds.

Printing Ink differs from writing ink in being thicker and more like a paint. It is usually made of lamp-black mixed with boiled LINSEED oil and turpentine. Rosin oil is used in cheap inks, and soap is also sometimes put in. Printing ink has to be made with the greatest care.

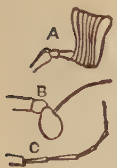
India Ink is made from fine lamp-black mixed with sized or animal glue, with a little perfume. The best black is said to be got from pork fat. The glue is made from buffalo hide. In China a little camphor is put in, and this is said to improve it.

The word ink is from the old English *enke*, which is probably from the Latin *encaustum*, the purple red ink used by the emperor in signing his name.

INSECTS. The body of every insect is made up of a certain number of rings, which are divided into three parts; one ring forms the head, three the thorax or chest, and nine to eleven the abdomen. All insects have three pairs of legs, all of which grow on the chest; the front pair on the first ring, the middle pair on the middle ring, and the hind pair on the last ring. The feet of some have claws; some have a kind of suction pad by which they can walk with the back downward; some are fitted for digging, and others for swimming. They have usually either two or four wings, also on the chest, but never any other number, though some have no wings at all, and in some kinds the males have wings and the females are wingless. In the two-winged insects, such as flies and mosquitoes, two little threads, each with a small knob or ball at the end, take the place of the second pair of wings, These are called balancers, but their use is not well known. In some other insects, as the beetles, the forward pair of wings are thick and strong and are used only as coverings for the others. These are named *elytra*, which means sheaths or wing-covers. When the insect is at rest the elytra are turned over the back, and the true or flying wings are folded under them.

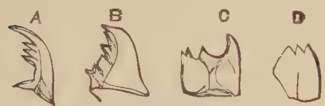
All insects have on their heads two very delicate organs of touch, or feelers, called *antennæ*, which some suppose to be also for hearing and smelling. The antennæ of different insects are of many forms, some of which are shown in the pict-

ure. There are also feelers called *palpi.* As insects feed on different kinds of food, some living on animal and some on vegetable substances, while others only suck juices, there is much difference in the shape of their mouths, some being formed for gnawing, cutting, and tearing, some only for sucking, and some for both gnawing and sucking. Gnawing insects, such as beetles and cockroaches, are called mandibulate insects, because they have a set of upper jaws called *mandibles*, with which they cut their food. Below them is another pair of jaws called *maxillæ.* Both of these jaws shut together sidewise. The mandibles are usually stronger than the maxillæ, are often toothed and hooked, sometimes have sharp cutting edges like scissors, and sometimes are made for bruising and grinding. There are also in this kind of insect an upper and a lower lip, which move up and down, and are as hard as the jaws.



Antennæ.

A, antenna of a kind of beetle; B, of a fly; C, of a dragon-fly.



Mandibles.

A, mandible of a kind of beetle; B, of a grass hopper; C, of a kind of dragon-fly; D, of the paper-making wasp.

Insects which live by sucking juices are called haustellate insects. They take in their food through a kind of proboscis, or tube, which runs out from the lower lip and which differs much in different insects in length and in shape. It is generally kept rolled up under the head, but can be uncoiled and run down into flowers to reach their juices. Mosquitoes and other insects which suck the blood of animals have a proboscis fitted with delicate lancet like bristles to pierce the skin.

Most insects have two large compound eyes, or eyes made up of a great number of small ones, on the side of the head, and three small simple or single eyes between them; but some have only compound eyes, and some only single eyes. The compound eyes are sometimes made up of as many as 25,000 small ones. Each eye of the common fly is composed of 4000 simple eyes.

Eggs of Insects. Most insects are hatched from eggs laid by the parent, and are therefore said to be oviparous (Latin *oviparus*, from *ovum*, egg, and *parere*, to bring forth). Most of them take no care of their eggs, but leave them to be hatched out by warmth, but bees, ants, and some others carefully rear their young. The number of eggs laid varies much: the flea lays about 12, many flies and beetles lay about 50, silkworms from 500 to 2000, while the queen bee will lay 40,000 to 50,000 in a season, and the white ant as many millions.

The Larva. Almost every insect passes through three different stages or changes of being. In its first stage, or when it comes out of the egg, it is called a *larva* (Latin *larva*, plural *larvæ*, a mask), because this is not its true form, but only the mask of the form to come. The larvæ of butterflies and moths are called caterpillars; those of beetles, grubs; and those of flies, maggots. The larvæ of other kinds of insects have no special names. Larvæ eat a great deal and grow very fast. The maggots of flesh flies increase their weight two hundred times in a day. Most larvæ change their skins four or five times.

The Pupa. A few days before the larva is ready to enter upon its second stage it becomes restless, stops eating, and usually spins a silken cocoon, or makes one of earth, chips, or leaves. When its house is finished it shuts itself up within it and

goes into a state of apparent sleep. During this period of rest, which is called the *pupa* state (Latin *pupa*, plural *pupæ*, a doll or puppet), a great change goes on, and the insect makes ready to enter upon its third stage, growing gradually into the form of the perfect insect. Most pupæ eat nothing, but lie motionless till the time comes for the third stage; but some, as dragon flies, which do not undergo a perfect change, are active and eat a great deal. The pupa of the butterfly or of the moth is usually called a *chrysalis* (Greek *chrusallis*, from *chrusos*, gold), on account of the golden color of its cocoon, and the pupa state is called the chrysallid state.

The Imago. The time in which the insect stays in the pupa state differs according to the changes of the seasons. Some pupæ lie in the cocoon all winter. When the right time comes the cocoon is broken and the full-formed insect, which a little while before was a crawling worm, appears as a bright and beautiful creature with wings, ready to sport in the sunshine and among the flowers. The insect in this third stage is called an *imago* (Latin *imago*, an image), because it is the image of its perfect condition. It grows but little after this, does not eat much, and is short-lived. The female hastens to lay her eggs either in, on, or near what is to be the food of the larva, and then dies.

Butterflies, moths, bees, beetles, flies, and some other insects undergo a perfect change from the worm-like form to the winged insect; but some others, such as grasshoppers, crickets, dragon-flies, etc., although they pass through the three stages, never have the worm form, and do not shut themselves up in cocoons. The full grown grasshopper differs from the young one only in having wings and in its size.

Insects inhabit the air, the earth, and the water. Some kinds are found in all parts of the world, and some only in particular places. The largest kinds live in very hot countries. Some, such as the bee, the silkworm, and the cochineal bug, are very useful to man; but many kinds, such as the locust, the grasshopper, the potato bug, and many flies, are very harmful, destroying herbage and crops. Insects have the senses of touch, sight, hearing, smell, and taste, and their instincts are so wonderful that they sometimes seem almost to be able to reason. Their muscles are very strong and active, and they can leap higher, fly swifter and longer, swim faster, dig more in a given time, and carry and drag heavier weights, in proportion to their size, than any other animals.

Insects are commonly divided into seven orders according to the shape of their wings.

I. **Hymenoptera,** or membrane-winged insects, which have four naked wings, with few veins on them, the two in front being much larger than the hinder ones. They include the bees, wasps, saw flies, ants, and others.

The word hymenoptera is from the Greek *humen*, membrane, and *pteron*, wing.

II. **Lepidoptera,** or scale-winged insects, which have four wings, with regular veins on them, covered with small scales. They include the butterflies and moths.

The word lepidoptera is from the Greek *lepis*, scale, and *pteron*, wing.

III. **Diptera,** or two-winged insects, which have but one pair of naked wings. Among them are the flies, mosquitoes, daddy-long-legs, and fleas. Although the fleas have no wings, they are looked upon as imperfect flies, and so are put into this class.

The word diptera is from the Greek *dis*, twice, and *pteron*, wing.

IV. **Coleoptera,** or sheath-winged insects, which have a pair of hinder wings for flying and a pair of horny ones in front for covering the real wings when the insect is at rest.

They include the beetles, of which there are many kinds.

The word coleoptera is from the Greek *koleos*, sheath, and *pteron*, wing.

V. **Hemiptera,** or half-winged insects, which are so called because their fore wings or wing covers are half thick and half thin; but some of this order, as the locusts, have both sets of wings so thin that one can see through them, and others, as the bed-bugs, have no wings at all. They are all alike, however, in having their mouths fitted with a horny beak made for suction, which has in it several stiff bristles for piercing. The chief families of the hemiptera are the plant-lice, body-lice, bed-bugs, chinch and squash bugs, water-bugs, and cicadæ, one kind of which is commonly called the "seventeen year locust."

The word hemiptera is from the Greek *hemi*, half, and *pteron*, wing.

VI. **Orthoptera,** or straight-winged insects, so called because their hinder wings, when at rest, are folded like a fan and laid straight along the sides of the back. Their front wings, which are somewhat thicker, are joined on the top, when closed, so as to make a kind of roof over the others. The mouths of this order are made for biting, and the hind legs are large and fitted for leaping. Among the orthoptera are included the crickets, locusts, grasshoppers, cockroaches, and earwigs.

The word orthoptera is from the Greek *orthos*, straight, and *pteron*, wing.

VII. **Neuroptera,** or nerve-winged insects, which have four large thin wings veined with a network of little nerves. The hinder wings are usually of the same size with the fore ones, but in some kinds they are smaller and in others are wanting. Their bodies are long and slender, and their mouths are made for biting. The principal neuroptera are the dragon-flies, commonly called devil's darning-needles, may flies, day flies, and white ants or termites.

The word neuroptera is from the Greek word *neuron*, nerve, and *pteron*, wing.

The word insect is from the Latin *insectum*, from *insecare*, to cut in, the bodies of insects being cut in so as to be nearly divided.

Elytra is the plural of the Latin *elytrum*, which is from the Greek *elytron*, a sheath.

Antennæ is the plural of the Latin *antenna*, a sail-yard.

Palpi is from the Latin *palpare*, to feel softly. Maxillæ is the plural of the Latin *maxilla*, a little jaw.

Mandibulate is from the Latin *mandibula*, from *mandere*, to chew. Haustellate is from the Latin *haustellum*, a sucker.

IODINE, one of the non-metallic ELEMENTS. It is a crystalline solid of a grayish-black color, with a metallic lustre like black lead. It melts very easily and turns to gas at common heat in the air, giving an odor somewhat like that of chlorine. Iodine exists in small quantities throughout the animal, vegetable, and mineral kingdoms; many mineral waters contain it, and it is found in sea-water and in almost all sea-weeds. It was discovered in 1812 by Courtois, a saltpetre-maker in Paris, in the liquor of kelp made by burning sea-weed in pits, and for a long time this was the common way of getting iodine, but now it is made chiefly from the sodium nitrate found in Chili. In 1889, about 6000 kegs of a hundred pounds each were exported from Chili. Iodine is largely used in medicine, especially in cases of rheumatism and swellings of the joints, which are usually painted with a solution of it, and as a disinfectant in hospitals. It is also used in the manufacture of aniline colors, and a little in photography.

The word iodine means violet like, from the Greek *ion*, a violet, and *eidos*, form.

IRIDIUM, a metal, one of the ELE-

MENTS. It is whitish and very hard and brittle. It is found sometimes pure and sometimes mixed with platinum and other rare metals. But little of it is got, as it is quite rare, and it is worth about $720 a pound, or more than twice as much as gold. It is used chiefly for making the points of gold pens. It was discovered in 1803 by a French chemist named Descotils.

Iridium gets its name from the Latin *iris*, rainbow, on account of the beautiful colors shown in some of its solutions.

IRON. The most abundant of the METALS, and one of the principal ELEMENTS. It is not found as a metal, but as an earthy ore, usually united either with OXYGEN (iron oxide) or with CARBON (iron carbonate). Sometimes masses of nearly pure iron have fallen from the air on the earth in the form of meteors (see AEROLITE), and have been used by the people of the countries in which they fell in making knives, spears, and other things. There is some iron in almost all rocks, earths, and waters, and it is found in the ashes of plants and in the blood of animals. The reddish color of many rocks and earths is made mostly by iron. When pure, iron is almost as white as silver, softer than wrought iron, and takes a very high polish; the iron of commerce is never entirely pure, but has always a little carbon, SILICON, SULPHUR, and PHOSPHORUS in it.

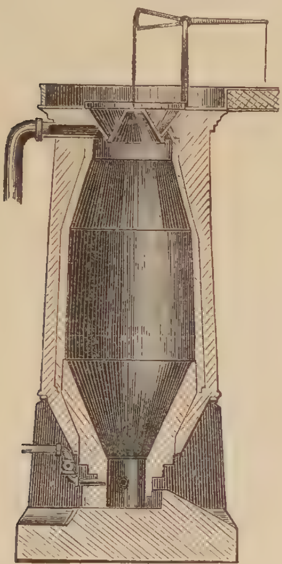
Iron Ores. Iron ore is produced in the United States in twenty-six States and two Territories. The four States producing the most are Michigan, Alabama, Pennsylvania, and New York; but a good deal is mined also in Minnesota, Wisconsin, Virginia, West Virginia, Tennessee, New Jersey, and other States. There are several kinds of ores from which iron in made. Red hematite is so called on account of its color, which is reddish-brown, the word being made from the Greek, *aima*, blood. A good deal of the pig-iron made in the United States and in England is from this ore. It is found in great abundance in Chili and other parts of South America, in Algeria, and in England, Norway, Sweden, and other parts of Europe. In the United States there are large beds of it in Michigan near Lake Superior, Alabama, Missouri, Wisconsin, Tennessee, New York, and Minnesota. In Missouri, two mountains, called the Iron Mountain and Pilot Knob, are largely made up of this ore.

Brown hematite, which includes bog, marsh, or lake ore, and ochre, gets its name from its general brownish color, though it is sometimes of a yellowish or reddish tint. It is found in many forms, as a hard stony ore and as a loose earth, but all kinds are only changes from other ores, made by the action of dampness, air, and other things. It is often found in marshy places, where it has been carried by streams from the hills around. This kind of ore is found in almost all parts of the world, and a great deal of iron is made from it, especially iron used for castings. The iron ores of Salisbury, Connecticut, and of Columbia and Dutchess Counties, New York, are of this kind, and much is found also in Pennsylvania, Michigan, and several Southern and Western States.

Magnetic iron ore, or magnetite, is usually found in large masses, and is easily known by its black color and by its being drawn toward a MAGNET. It does not get its name from this, but from the ancient country called Magnesia, in northern Greece. Most of the iron ore in Sweden and Norway is of this kind, and there are whole mountains of it among the Ural Mountains. In this country it is found in the Adirondack Mountains in New York, in northern New Jersey, Pennsylvania, Michigan, and other States. Magnetic iron ore is one of the richest in pure metal, and from it is made the finest iron and the best steel.

Siderite is an iron ore made up mostly of iron carbonate, lime, and magnesia. From it is made a kind of cast iron. It is found chiefly in Germany, England, and at Roxbury, Connecticut.

Cast-Iron, or pig-iron, as it is commonly called, because it is moulded in little bars or pigs as it runs from the furnace, is made by smelting or melting iron ore in a blast furnace nearly as high as a four-story house (50 or 60 feet). The picture shows such a furnace cut down through the middle so that



Blast Furnace.

the inside can be seen. It is closed at the bottom, the air needed for the fire being blown through pipes called *tuyères* (pronounced *tweers*), one of which is seen on the left near the bottom, while the hole through which another one enters is shown at the back part near it. The furnace is called a blast furnace from the blasts of air thus forced into it.

The furnace is filled from the top with layers of coal, ore, and limestone, which are thrown in one after the other until the inside is filled up. The limestone, commonly called the "flux," is put in to take out the earthy impurities, with which it mixes. When the furnace is once fired the fire is never allowed to go out until it is necessary to build a new furnace. Sometimes one will keep on burning for years, new layers of fuel, ore, and limestone being thrown in as fast as the iron melts down. The blast of air at the bottom makes a very great heat; the ore melts and runs down into the bottom part of the furnace, and the flux unites with the earthy matters, forming a kind of glassy matter called "slag." This, being lighter than the iron, flows on top of it, and finally flows off over a place called the dam, leaving the melted iron by itself. The iron is allowed to run off now and then through a hole, called the tapping hole, at the bottom of the furnace, which is closed with sand when not in use. The metal flows out in a bright golden stream into sand moulds on the floor, where it cools and becomes pig- or cast-iron.

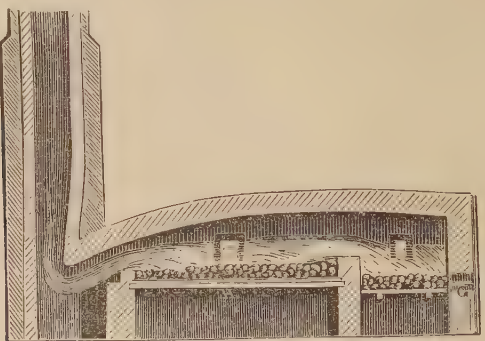
The funnel, or cone-shaped hood with which the top of the furnace is closed, is put on to collect the gases, which would pass off into the air if the top were left open. These gases have a great deal of heat in them, and are carried off through the pipe at the top and burned in another kind of furnace, where they are used to heat the air which is forced into the furnace through the *tuyères*.

Wrought-Iron. Cast-iron is only fit for making things which are cast in moulds, such as gas and water pipes, lamp-posts, pillars and fronts for buildings, railings, and heavy stoves. It is not pure iron, but has carbon in it, and cannot be hammered, as it is brittle, and will easily break. To make it into wrought-iron—that is, softer iron which can be hammered or rolled into plates—the cast-iron is melted in

another kind of furnace, and stirred up so that the air can get to it. This, which is called puddling it, burns out the carbon, silicon, sulphur, phosphorus, and other impure things in the iron.

The furnace in which this is done is shown in the second picture. The iron to be heated is not put right on the coal; the fire is built on the grate G, and the iron is put on the hearth H. The flame passes over the hearth, and the heat is reverberated or driven down on the iron from the low rounded roof. For this reason such a furnace is called a reverberatory furnace. When the cast-iron on the hearth is so nearly melted that it makes a kind of paste, it is gathered in lumps on the end of an iron bar and carried to a power HAMMER, under which it is hammered while red-hot. This forces out the liquid slag and makes the iron into a solid mass. Sometimes instead of hammering, the hot iron is squeezed in strong iron jaws called squeezers.

Wrought-iron thus made is softer than pig-iron, and may be easily hammered into bars, rolled into plates, and drawn out into wire. From it are made the iron plates for steam boilers and ships, anchors, chain cables, wire, ploughs, wheel-tires, horseshoes, shovels and spades, nails and spikes, and the iron



Reverberatory Furnace.

part of most tools. Wrought-iron can be welded—that is, pieces of it can be united into one by hammering them together when red-hot. Welding is now done more easily by electricity. The parts to be welded are put together and subjected to a strong current of electricity which heats them white-hot and causes them to unit.

Malleable-Iron is not wrought-iron but a kind of cast-iron which is made very tough by baking for six to ten days in a furnace. Things made of it are cast first and baked afterward. This takes out much of the carbon, and makes the iron less brittle and therefore less apt to break. If the cast-iron used was good, the things thus made are tough enough to be hammered, on which account they are called malleable, from Latin *malleus*, a hammer. A much quicker way of making malleable-iron has lalely been found out.

Steel is iron which has more carbon in it than wrought-iron and less than cast-iron; so its hardness is between that of wrought-iron and cast-iron.

Iron does not change in fresh air, but in damp air it soon unites with the oxygen of the air and rusts. When iron nails, screws, and bolts used in building ships, houses, bridges, etc., rust, they give up some

of the oxygen to the carbon of the wood which they touch, and the wood is thus slowly eaten or burned away. Iron may be kept from rusting by covering it with a thin coating of ZINC, making it into what is wrongly called "galvanized iron."

Another way is to heat it in very hot steam. This makes a black coating on the iron, through which the oxygen of the air cannot get, and the metal therefore cannot rust.

Iron is often given as a medicine. The human body has considerable iron in it, especially in the blood, which is mostly colored by it. The food which we eat usually has iron enough in it to keep up the needed supply, but sometimes the BLOOD does not have enough of the red corpuscles in it, and then it is necessary to give iron as a tonic, that is, to give strength.

Great Britain used to make more iron than any other country in the world, but now the United States excels in the production of both iron and steel. Great Britian comes second, and after her come in order, Germany, France, Sweden, Austria, Belgium, and Russia. The most important iron shipping port in the world is Escanaba, Michigan, which in 1890 shipped 3,700,000 tons of iron ore.

History. Iron has been known and prized from very early times; articles made of it having been found in the Great Pyramid of Egypt, where they are believed to have been for 5000 years. In the British Museum are picks, hammers, and saws of iron, found in the ruins of Nineveh, of a date not later than 880 B. C. Schliemann found iron in the ruins of Mycænæ, which was destroyed 561 B. C. The Chinese have used iron from a very early period, and the Romans made iron in Britain. It is not known when the blast furnace was first introduced, but it was used in the middle of the sixteenth century. The hot blast was introduced in 1829. In recent years the whole method of iron and steel making has been changed by the inventions of Bessemer, Siemens, Krupp, Thomas, Gilchrist, and others.

The word iron is from the Anglo-Saxon *iren* or *isen*, iron.

ISINGLASS, the purest kind of GELATINE. The best is made from the air-bladders or sounds of the sturgeon caught in the Black and Caspian seas; but isinglass is made also from the bladders of cod and other fish. It is colorless, has no smell, and melts easily in hot water, making a clear, beautiful jelly. It is much used for making blanc-mange, jellies, ices, and other kinds of desserts. A poor kind of isinglass is used for fining or clarifying beer.

Isinglass Glue, sometimes called diamond CEMENT, is made of isinglass and gum mastic melted in weak spirits of wine or in gin. It makes a hard, milk-white jelly; it should be warmed before using. Isinglass mixed with gum is used for giving a gloss to silk.

Court Plaster is made by spreading a thick coating of isinglass on silk. It is called isinglass plaster when made with muslin or linen instead of silk.

The thin pieces of MICA used in stoves are commonly called isinglass.

The word isinglass is said to be a corruption of the Dutch *huizenblas*, the bladder of a large kind of sturgeon.

IVORY, the hard white substance which forms the tusks of the elephant. This is the pure ivory, but the tusks of the hippopotamus, walrus, narwhal, and other animals are sometimes used in the arts for the same purposes as ivory, and are often called ivory. The tusks of the African elephant yield the best ivory, and many thousands of them are used every year in the manufacture of knife handles, billiard balls, chessmen, dice, fans, combs, paper-knives, napkin-rings, organ and pianoforte keys, etc. It is thought that twenty thousand elephants are

killed yearly in Asia and Africa for their tusks. Much ivory is brought also from Siberia, taken from dead mammoths or fossil elephants found frozen up under snow and ice in the far North, where they are supposed to have lain for thousands of years. This ivory is very hard and brittle, and whiter than other ivory.

Ivory can be bleached and dyed of various colors. It can also be made flexible, so that it will bend as easily as leather. Great taste and skill are often shown in working ivory, and some of the carved toys and ornaments made of it are very beautiful. The Chinese and Japanese are very skilful in carving it.

Vegetable Ivory is the nut of a kind of palm tree which grows in South America. The nut, which is about as large as a hen's egg, contains a sweet liquid which gradually thickens until it becomes hard and white. It looks much like ivory and may be used instead of it for many things, such as buttons, umbrella handles, and cane heads.

The word ivory is in French *ivoire*, and is from the Latin *ebur*, ivory.

IVY, a climbing evergreen plant, common in southern and western Europe, and especially in Great Britain; usually called English ivy. The ivy climbs to the tops of high trees and buildings, and covers rocks and ruins with its beautiful leaves, which are dark green, smooth, and shiny. It is also trained in gardens to form screens and evergreen walls. In this country it does not succeed very well as far north as New York, though fine specimens are sometimes seen, but it grows luxuriantly in Virginia. In the Northern States it is much cultivated as a house plant, being trained to run over windows or along the cornices of rooms. What is called German ivy is not an ivy, but a kind of vine which came first from the Cape of Good Hope. It is a very pretty house plant, but does not do so well out of doors, as it is killed by the first frost. The Virginia creeper, a beautiful climbing vine of the grape family, is sometimes called American ivy. Poison ivy, sometimes called also poison oak and mercury vine, which climbs over rocks and fences and even up tall trees, is properly a SUMACH and not an ivy.

The word ivy is from the Anglo-Saxon *ifig*, ivy.

J

JACKAL. This animal is found in Asia, Africa, and in European Turkey, but nowhere else in the world. It looks like the fox, but is taller. Its fur is grayish yellow above, and white below, and its tail is tipped with black. Jackals usually sleep during the day, and go out at night in troops, sometimes more than a hundred together, to hunt for food. They keep up a constant howling, making a sad, harsh sound, which is horrible to hear at night. They are afraid of men, but they will often steal into houses and carry off everything that they can eat, even boots and shoes, harness, and other things made of leather. But they live mostly on decayed things, and, like hyenas, often dig up dead bodies. In some countries graves have to be covered with large stones and prickly bushes to keep them from being dug open.

The ancients said that the jackal always went before the lion to find prey for it, and that the lion gave it in return the remains of its meal, but there is no truth in the story.

The jackal can be tamed, and taught to know its master. It acts much like the dog, and some think that the dog is descended from the jackal.

The jackal is a MAMMAL of the order *carnivora* or flesh-eating animals, and of the same family with the dog, the fox, and the wolf.

The word jackal is from the Arabic *jaqal*, jackal.

JADE, a kind of stone highly prized, especially in the East, for ornamental carving. Jade proper is nephrite, a kind of hornblende, a silicate of CALCIUM and MAGNESIUM. The most valued kind of jade is properly called jadeite, a silicate of ALUMINUM and SODIUM. It is not so tough as jade, and it has a more brilliant lustre. It is generally white, changing into various shades of green, sometimes with veins and spots of emerald green. The Chinese have long used it for making rings, bracelets, cups, vases, and other ornaments, and Chinese jadeite is famous among collectors. Many implements of jadeite have been found in tombs and mounds in Mexico, Central America, and Peru, as well as in New Zealand and the islands of the Pacific. Some have been brought, also, from Alaska.

The word jade is from the Spanish *ijada*, the side or flank. The stone was called *piedra de ijada*, stone of the side, because it was supposed to cure pain in the side.

JAGUAR. In South America, where this animal is chiefly found, it is sometimes called panther, and sometimes South American tiger. It is but little smaller than the tiger, and is so strong that it can drag off an ox or a horse with ease. Its fur is usually brownish yellow, beautifully marked with circles of black with dark spots in them. The jaguar lives in thick forests near large rivers, and feeds chiefly on live animals and fish. It is a good climber, and often lies in wait on the limb of a tree and springs on the back of its victim as it passes beneath. It is also a good swimmer, and is said to stand in the water and throw out fish with its paw as they swim along.

Jaguars have been killed as far north as Louisiana, but they are now scarce except in the wildest parts

of South America. Their skins are very handsome, and are much prized for robes.

The jaguar is a MAMMAL of the order *carnivora* or flesh-eating animals, and of the cat family, which includes also the LION, TIGER, LEOPARD, PANTHER, COUGUAR, LYNX, and common CAT.

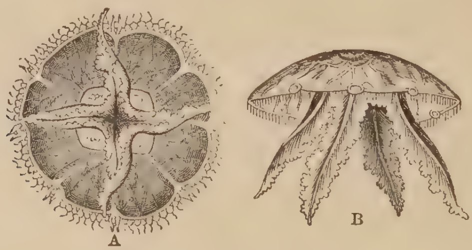
The word jaguar comes from *jagodra*, the Brazilian name of this animal.

JANUARY. See CALENDAR.

JASPER, a kind of precious stone, used for rings, seals, and other ornaments, and also for the decoration of costly buildings. It is a sort of quartz, but has clay mixed with the silica (see SILICON) of which it is chiefly made up. There are many colors of jasper, and some are spotted, striped, or clouded very beautifully. It is found in many parts of the world, but the finest kinds come from Spain, Hungary, Egypt, and Siberia. Very fine jasper is found also in Trego County, Kansas, where it may be got in large blocks, and of many colors, beautifully veined and shaded.

The word jasper is from the Latin and Greek *iaspis*, jasper.

JELLY FISH. In walking along the sea beach after the tide has gone out, we often see on the sands round, jellylike masses of a greenish-yellow color. These dirty-looking things, from which we turn away



Jelly Fish.
A, Bottom View; B, Side View.

in disgust, are, when in the water, among the most beautiful of ocean animals. Though they have no solid matter in their bodies, which are made up mostly of water, they have in them a kind of soft network, which holds their parts together. They have too a mouth and a stomach, for they eat like other animals, and solid food, such as CRUSTACEANS, MOLLUSKS, and even small fishes, has been found in them.

One of the commonest kinds of jelly fish looks much like a floating umbrella, or rather like a mushroom with the stalk split into four parts, and fringed on all the edges, as shown in the picture in B, which is the way it sits in the water. In A is shown the under part of the animal, with the mouth in the middle and the four feelers stretching out from it. These feelers are also graspers, with which they catch their prey. Their fringed edges have the power of stinging, and it is supposed that this helps them in catching animals for food, like the poison used by some insects. When touched by the hand or any other part of the human body, they cause a sharp pain like that made by the stinging leaves of the nettle; for this reason the jelly fish is sometimes called the sea-nettle.

When floating the jelly fish looks like a mass of whitish jelly, marked

with many soft delicate colors, like those seen in the OPAL. Much of the phosphorescence or light seen in the sea is made by the jelly fish. It moves along in the water by waving the fringed edges of its umbrella-like top, and thus makes long voyages on the surface of the sea. If an enemy touches it or it strikes against anything, it folds itself up and sinks down into the depths. In some places jelly fish cover the whole top of the sea in such numbers as to furnish much food for whales and many crustaceans. They are found in all seas, both in hot and in cold countries, but in warm places they are much larger than those seen on our coasts, being sometimes three or four feet wide.

The jelly fish belongs to the class of radiate ANIMALS.

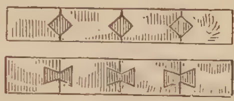
JET, a black mineral, easily cut and carved, which takes a beautiful polish. It is a kind of bituminous coal, but harder and smoother than that used for burning. Much of it is found near Whitby, in England, and it is made there into necklaces, earrings, brooches, bracelets, and other trinkets, mantel ornaments, buttons, etc. Good jet is found also in Spain and France, and largely made into crosses and rosaries. False jet is made of black glass, hard black wax, and other things.

The word jet is from the Latin and Greek *gagates*, and the stone was named from the river Gagas, in Lycia, Asia Minor, near which much jet was found.

JEWS-HARP, a simple musical instrument, made of metal. When played it is held between the teeth, and a little spring or tongue is made to vibrate or tremble by being struck with the finger while the performer draws in and breaths out air. The tones are made by the way the air strikes on the tongue while it is vibrating. The jews-harp has been known for two or three hundred years, and several musicians have given concerts with it with great success.

It is not known how the jews-harp got its name. Some think it is so called because it was used by the Jews, but it is more probable that jew is only a changed form of the French *jeu*, toy, and that the name means toy-harp.

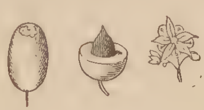
JOGGLE, a joint made between two bodies by cutting jogs or notches in their sides, and fitting in pieces. The joint is also called joggle-joint and joggled-joint, and the pieces put



Joggle-Joints.

in are called joggles. In the picture two kinds of joggles, used in stonework, are shown. The pieces set in, which are of stone or metal, keep the blocks of stone from sliding.

JUJUBE, the fruit of a small tree which grew first probably in the north of China, whence it was carried westward. The Romans found it growing in Syria and took it to Italy about the time of Augustus. It is now cultivated all around the Mediterranean. The fruit is of the shape and size of an olive, but is red or yellow when ripe. It is dried



Jujube.

as a sweetmeat; but the jujube paste sold in candy stores is made out of gum arabic and sugar, and has no real jujube in it.

The word jujube is from the Latin *zizyphum*, Greek *zizuphon*, from the Arabic *zizuf*.

JULY. See CALENDAR.

JUNE. See CALENDAR.

JUNIPER, an evergreen shrub of the same family with the cypress. The common juniper of Europe seldom grows as high as a man, ex-

cepting when very old. It bears dark purple berries about as large as a pea, which have a brownish pulp with three seeds. They have a sweetish and bitterish taste, and a flavor like turpentine. The oil of juniper is distilled (see ALCOHOL) from them, and they are put into GIN, giving that liquor its flavor.

There are several kinds of juniper in the United States, especially in Arizona, New Mexico, Utah, and California, whose fruit furnish food for the Indians. The berries are eaten raw, and quantities are dried and laid up for winter, when they are ground fine and made into bread, or boiled for mush. The Indians also make the bark of one kind into saddles, skirts, and mats to sleep on.

The word juniper is from the Latin *juniperus*, the juniper tree.

JUPITER, the largest of the planets of the solar system (see UNIVERSE). It is the brightest of the superior planets, or those outside the earth. Its diameter is nearly 86,000 miles, so that it is about 1300 times as large as the earth. Its distance from the sun is 483,000,000 miles, and it goes around it once in a little less than twelve years. While its year is thus very much longer than ours, its day is shorter, for it revolves on its axis in less than ten hours. Seen through a telescope, Jupiter looks light yellow with darker salmon-colored bands extending around the equatorial part, and with forms like clouds almost all over its surface. It is thought that we see only clouds and not the body of the planet. Jupiter has five satellites or moons, invisible to the naked eye, but looking through a telescope like brilliant points of light. Four of them were first seen in 1610, by Galileo, the inventor of the telescope. The smallest of these is about as large as our moon, and the largest somewhat smaller than Mars, The fifth satellite was discovered Sept. 9, 1892, by Prof. E. E. Barnard at the Lick observatory, California. It is much smaller than the others, and can be seen only through the strongest telescope. It goes round Jupiter once in twelve hours.

Jupiter, the outermost, excepting Saturn, of the plants known to the ancients, was named from the god Jupiter.

JUTE, a material some like hemp, made from the inner bark of East Indian plants of the same name. The plants, which are natives of Asia, are annuals, and grow ten to twelve feet high. The leaves of one kind are largely used in Syria and Egypt as a vegetable. But the plant is valuable chiefly for its fibres, much used in various manufactures. They are strong, coarse, dark brown in color, and often twelve feet long. Jute is largely made into coarse bagging and sacking called gunny cloths, used in the Southern States for baling cotton. Gunny bags, in which pepper, sugar, rice, gums, etc., are shipped from India, are also made from it. Much jute is sent to Dundee, Scotland, where it is manufactured into floor matting and carpets. In India the stems of the leaves are made into baskets and coarse paper, and sometimes into charcoal for gunpowder and fireworks.

For a long time no way of whitening jute was known, but it is now bleached beautifully and its fibres divided into threads as fine as silk, which can be carded and spun. It has some of the qualities of linen, hemp, and cotton, and is now much mixed and woven with silk. It is mixed also with cotton, linen, and woolen, especially in making shirtings and coat linings, and is used in paper making. The word jute is from the Bengalese *jut*, the fibres of the jute plants.

K

KALEIDOSCOPE, an instrument in which beautiful forms or images may be seen. It is made up of a tube, having at one end an eye-glass, and at the other end two glasses with little pieces of broken colored glass put loosely between them, so that they can move about. Inside the tube, and running lengthwise with it, are narrow strips of looking glass, or of glass blackened on the back, put together at the edges with the faces inward. Three strips of glass are commonly used, but sometimes four or five, and even more, are put into kaleidscopes. In looking into the tube the bits of colored glass between the end glasses are reflected in the looking glasses and made to appear in regular figures of most beautiful forms, which change whenever the instrument is shaken. The kaleidoscope is a very pretty toy, and is also much used by pattern drawers and others, who get from it a great many different designs. The first kaleidoscope was made in 1817 by Sir David Brewster.

The word kaleidoscope is made up of the three Greek words *kalos*, beautiful, *eidos*, image, and *skopein*, to see.

KANGAROO. This animal is found only in Australia, New Zealand, New Guinea, and the neighboring islands. There are many kinds and sizes, from the great gray or giant kangaroo, which is taller when standing than a man, down to the hare and the rat kangaroo, which are not much larger than the animals after which they are named. Some are fitted to live in deserts, some in mountainous places, and some in trees; some are gray, some black, and some red. Kangaroos have very long and strong hind legs by means of which they make leaps of fifteen feet or more, going faster than a horse can run. When sitting they rest on the hind legs and the root of tail, which is long, thick, and strong. Their fore legs, which are quite short, are used for digging, for grasping things, and for putting food into the mouth. The head is small, much like that of a deer, and with large mild eyes. They eat only vegetable food, such as grass, leaves, tender buds of trees, and roots, and they can go a long time without water. The female has but one young at a birth, which she carries in a kind of pouch, where it remains until old enough to care for itself. When about eight months old its little head may sometimes be seen reaching out of the pouch to crop the grass on which its mother is feeding. When old enough it jumps out and runs beside her, but if the mother scents danger she thrusts it back into the pouch and leaps away with it. The young are pretty little creatures, with soft silvery fur, sharp ears, and bright eyes.

Kangaroos are much hunted, both for sport, just as the fox is chased in England, and for its flesh, which is much esteemed for food, and its skin, which makes excellent leather. A strong, swift breed of dogs, part mastiff and part greyhound, is trained to chase kangaroos, which is dangerous business. The huntsmen, mounted upon swift horses and armed with a spear which has a club at the other end, ride into a herd and use both spears and clubs. The animals, when brought to bay, will fight

bravely with claws and tails, often tearing a dog open with a single blow; and sometimes one will seize a dog with its fore paws, run with it to a water hole, and hold it under until it is drowned. The kangaroos are skinned and the skin pegged down on the ground to prevent shrinkage, each man marking his own. When each has a hundred skins the huntsmen return home and sell them. Almost all the skins are sent to Newark, New Jersey, where they are made into leather, which is sold to England, France, Germany, and other countries, some being sent back to Australia. As it is nearly water-proof, it is excellent for making shoes.

The kangaroo is so much hunted that it is feared that it will soon be as scarce in Australia as the buffalo is in America. It is said that 6000 skins are received at Newark every week. At this rate it would take only a few years to use them all up, as there were only 1,800,000 in Australia in 1887. The kangaroo can be easily tamed. Several years ago Baron Rothschild had several

Herd of Kangaroos.

brought from Australia and turned loose in Tring Park, his residence in England, and they have now increased to more than thirty.

The kangaroo is a MAMMAL of the order *marsupialia*, or pouch-bearing animals, to which belongs also the OPOSSUM.

The word kangaroo formerly spelled kanguroo, is Australian.

KAOLIN. See CLAY.

KATYDID. See GRASSHOPPER.

KINGFISHER. The belted kingfisher is the only one of this family of birds found in North America. It has a large head with a crest, and a long straight bill. Its color is blue above and white on the breast, with a blue band across the breast, whence it gets its name of belted. It lives near fresh water rivers and lakes, and may often be seen skimming along the surface of the water looking for fish, on which it feeds.

When it sees a fish, it stops suddenly, dashes down headlong into the water, seizes it with its bill, carries it to a stump or tree, and swallows it head foremost, unless it be too large, when it first breaks it to pieces. It

makes its nest in deep holes which it digs in the river's bank, and lays usually six white eggs.

The European kingfisher, which is much like the belted kingfisher in its habits, is the halcyon of the ancients, who believed that the sea stayed calm for a few days while the bird was building its nest. These days, which were the seven days before and the seven days after the winter solstice (21st December), were therefore called halcyon days.

The kingfisher belongs to the order of *insessores*, or perching BIRDS.

The word kingfisher is made up of the Anglo-Saxon *cyng*, king, and *fiscere*, fisher.

KITCHEN-MIDDENS. On the sea coast of many countries have been found great heaps of refuse, left by the ancient peoples who lived there. These heaps, first noticed and examined in Denmark, were called *kjoekken-moeddings* (Danish *kjoekken*, kitchen, and *moedding*, heap of refuse), because they were like the refuse thrown out from kitchens, and this name has been retained for them in English. They are made up chiefly of oyster, mussel, and periwinkle shells, and the bones of animals, birds, and fishes; but among them have been found also the cinders of fires, rude pottery, and many implements of flint, bone, and horn, but no metals. These finds show that the people who made the middens belonged to the stone AGE, probably about the time of the first LAKE DWELLINGS; that they were savages who lived in tents or huts, practised hunting and fishing, and ate their spoils on the spot, dropping the refuse until it grew little by little into great heaps. They thus teach us much about the early history of MAN. Kitchen-middens have been found also in England, Scotland, France, and other parts of Europe, in Australia, in South America, and on the coasts of Maine, Massachusetts, Florida, and Georgia, in the United States.

KITE, the common name of a bird of prey of the hawk family, which flies very high, soaring on the wing in the clouds as if it were floating on the air. Among the kites found in America is the swallow-tailed kite, a large bird, with long pointed wings and forked tail. It is a shy bird and keeps on the wing almost all day, sometimes flying so high that it can scarcely be seen, and coming down at night to roost on tall trees. When in the air it lives mostly on insects, but it eats also moles, rats, mice, small birds, and poultry. It builds its nest in the top of high trees, and lays five or six greenish-white eggs, with brown blotches on the larger end.

The kite belongs to the order *raptores*, or BIRDS of prey, and to the FALCON family, which includes also the EAGLES, falcons, HAWKS, and BUZZARDS.

The Saxons called this bird *cyta*, and from this our name has come.

KITE. Kites get their name from the kind of hawk called a kite, which may often be seen in the air almost as still as a paper kite, gliding along without moving its wings.

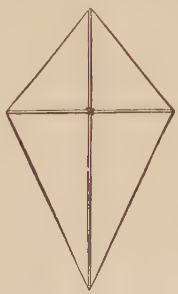


Fig. 1.—Cross Kite.

Paper kites may be made of many different shapes, but the most common kinds are shown in the pictures. Fig. 1, made by crossing two sticks, is called a cross kite; Fig. 2, made with three sticks, is a house kite; and Fig. 3, made with one straight

stick and one bowed stick, a bow kite. The sticks must be first tied tightly together, and a string is then put round the outside, in notches cut for it, to paste the paper on to.

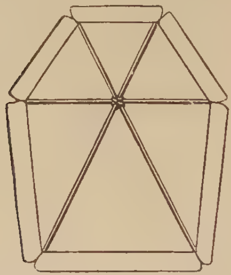


Fig. 2.—House Kite, showing the way of cutting the paper.

A tail of paper or cloth is usually fastened to the bottom of the kite, to give it steadiness when the wind blows strong.

The Chinese and Japanese are very skilful in making kites, and in their countries both old and young may be seen flying them in good weather. The frames of their kites are made of light bamboo sticks, and the cov-

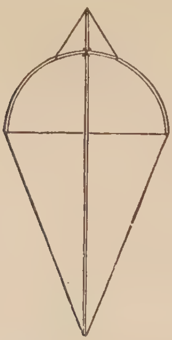


Fig. 3.—Bow Kite.

ers are of thin but very tough paper. They are of a great many different shapes, not only like our kites, but often like animals, ships, carts, castles, trees, and flowers. Sometimes castles, palaces, or pagodas may be seen in the air with all their windows lighted by small lamps, so as to look like real houses at night. These lamps often set fire to these air castles, and burn them up, which makes a very pretty sight. Some kites are like great bouquets of flowers, or like trees with leaves, flowers, and fruit on them, the fruit containing fireworks which go off in the air; and some are hung with lanterns or made like fire-wheels, the spokes of which have fire-flies fastened to them. In Japan one may often see in the air a whole menagerie at once, such as horses, cows, dogs, monkeys, owls, hawks, bats, crows, fishes, and snakes, as well as dragons, babies which cry, boys with their arms and legs spread out, hunters with bows and arrows, and soldiers with battle axes and spears. Many of these kites have a thin strip of bamboo or whalebone stretched tightly across the top, which hums, buzzes, or sings in the air like a hurdy-gurdy or a swarm of bees. Live birds do not like the kite birds that hum, and keep far away from them. Japanese boys send messengers up to their kites just as American boys do, but they also do some other things not known in this country. They dip about ten feet of the string next to the kite into glue and then into bits of broken glass; when the string is dry it is covered with many little blades of glass as sharp as a razor. When two boys are flying kites they often try to cross each other's string, and the more skillful one saws off the cord of the other one with his glass string. Many Japanese kites have no tails, but some have two, one at each corner, made of rice straw.

Kites are sometimes used by engineers to carry lines across deep chasms. This can be done only when the wind is right, so that the kite will fly over the place where the line is wanted; it is then made to fall down so that those on the other

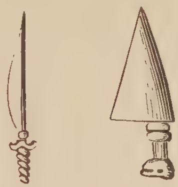
side of the chasm can get hold of the string. Larger and larger cords can be fastened on and drawn over until one of the size wanted has been carried across. In this way the first wire of the Niagara suspension bridge was got across the Niagara River. Kites have also been used in a similar way to get a rope to a vessel wrecked near shore, and many lives have been thus saved.

But the most important use to which a kite was ever put was when Dr. Franklin employed one during a thunder storm (June 15, 1752) to draw down lightning from the clouds, thus proving that it is the same as that made by the electrical machine. He covered his kite with a silk handkerchief instead of with paper, because silk is a better non-conductor than paper. The kite had fastened to it a pointed iron wire and to this he tied the string by which he flew it. He thought that some of the lightning would be drawn from the clouds by the wire, and would go from it down the hemp string instead of to the silk kite. If he had held the string in his hands, the electricity would have passed from it to his body and thence to the earth; but he prevented this by tying a silk ribbon to the end of the string and holding on to that instead of the string. The electricity could not pass through the non-conducting silk, and so it stayed in the string. He now fastened an iron key to the end of the string. As iron is a better conductor than hemp, the key became filled with it, and Franklin found, when he put his knuckle to it, that sparks came from it, just as they do from the conductor of an electrical machine. He also found, when he held a Leyden jar to the key, that the ELECTRICITY would go into the jar and charge it, and that he could use this electricity in the same way as that got from an electrical machine. Before this time it was supposed that lighting and electricity were the same, but nobody actually knew them to be so until Franklin brought down the lightning to earth with his kite. By using his kite in this way he also found out how to make LIGHTNING rods for the protection of buildings.

KNIFE. In the most ancient times, shells, flints, and sharp-edged stones were used for knives. Sometimes stone knives were made with a kind of handle and ground sharp on the edge, like the one shown

Ancient Stone Knife.

in the first picture. In time men found out the use of copper and tin, and then they made BRONZE knives. Almost all nations in ancient times used knives and other cutting instruments made of bronze. Pictures of bronze knives used by the Greeks and Romans are shown in the cuts below. But knives of iron and steel



Ancient Bronze Knives.

came into use very early, and after a while took the place of bronze as they were found to be stronger and more lasting.

The best knives are now made of steel, although a good many cheap ones are made of iron. Table knives are usually partly of steel and partly of iron; the blade is steel, but the shoulder, or raised part near the handle, and the tang, or part which fits into the handle, are iron. Table-knife blades are commonly made from a bar of shear-STEEL, which is heated white hot and then hammered

out into shape on an anvil by two workmen, one with a heavy and one with a light hammer. This is called forging the blade. As each blade is made it is cut off, and when the bar becomes too short to hold in the hand, it is held in a pair of tongs until it is all used up. Penknife and razor blades are usually made of cast-steel. Knife blades are hammered out on a flat anvil, but razor blades, which are hallowed out on the sides, are made on a round-faced anvil. After the knife blade is made it is fastened on to an iron bar by heating them both red-hot and hammering them together until they become one piece. This is called welding. The shoulder and tang are then forged from the iron and cut off like the blade.

Penknife blades are forged from the end of a rod of cast-steel, with a light hammer on a small anvil. After the blade is done, enough more of the steel is cut off to make the joint, or part by which it is fitted to the handle. The blade is then held in a pair of tongs and heated again, when the joint is forged. The nick, or nail-hole as it is called, in the side of the blade is stamped with a chisel while it is hot.

After forging, knife blades are stamped with the maker's name, and then tempered by heating them red-hot and cooling them quickly by dipping them into water. They are afterward ground and polished and fitted with handles. The handles of the best table knifes are made usually of ivory, though sometimes mother-of-pearl and tortoise shell are used, and sometimes gold and silver. Cheap knives are handled with CELLULOID, a false ivory made out of gun-cotton and camphor, and with stag-horn, cow-horn, and different kinds of wood.

Penknives and other pocket-knives pass through a great many hands before they are finished. Besides the blades, there are the springs, the scales or thin iron plates on the sides, the parts of the handle, and the rivets, the making of each of which is a separate trade. When all the parts are ready, they go to the finisher, who puts the knife together.

There are a great many kinds of knives used in different trades, but most of them are made in the same

Drawing Knife.

way. Drawing knives, much used by farmers for making shingles, and by coach and wagon makers, are shaped like the one in the picture.

The bowie knife is a kind of knife once much worn by men in the South and Southwestern States, where they were used both as hunting knives and in street fights. It is quite long usually, and has a wide,

Bowie Knife.

sharp blade, shaped like the one in the picture. The first knife of this kind was made by Colonel James Bowie of Texas, and his name was therefore given to it.

Our word knife cames from the Anglo-Saxon word *cnif*, knife.

KNOTS. It is very useful to know how to tie knots. Sailors, who have much to do with ropes, use a great many different kinds, some of which are hard to learn. In this article can be given only a few of the simpler ones, which can easily be understood from the pictures. In all these the rope is shown before the knot is drawn tight. When a rope is folded together or bent round, the loop part is called the "bight." In tying a knot in a single rope the

part held in the left hand is called the "standing part."

The **Overhand Knot,** one of the simplest kinds, is made by passing the end of the rope over the standing

Fig. 1.—Overhand Knot.

part and then up through the bight, as shown in the picture, Fig. 1.

The **Half Hitch** is made by passing the end of the rope under the standing part and then down through the

Fig. 2.—Half Hitch.

bight. The picture, Fig. 2, shows two half hitches, one made above the other.

The **Figure of Eight** is made by making a loop at the end of the

Fig. 3.—Figure of Eight.

rope, and then passing the end under and around the standing part and up through the loop, as in Fig. 3.

The **Bowline Knot** is made by lay-

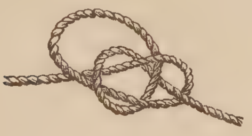


Fig. 4.—Bowline Knot.

ing the end of the rope across the standing part so as to form a loop, then passing the end up through the loop, then under the rope below the loop, and lastly down through the loop again, as shown in Fig. 4.

The **Common Bend** is a knot tied with two ropes. It is formed by passing the end of one rope up

Fig. 5.—Common Bend.

through the bight of another rope, then under and around both parts and lastly down through the bight again, as in Fig. 5.

The **Sailor's Knot** is made by passing the end of one rope down through the bight of another one, then pass-

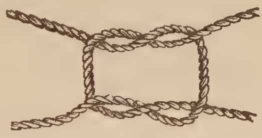


Fig. 6.—Sailor's Knot.

ing it over one side and under the other side of the second rope, and finally down through the bight, as in Fig. 6.

The **Fisherman's Knot** is something like the sailor's knot, but dif-

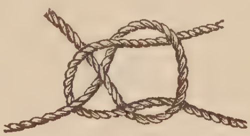


Fig. 7.—Fisherman's Knot.

fers in the way the ends are put, as can be seen in the picture, Fig. 7.

The word knot is from the Anglo-Saxon *cnotta,* which is probably from the Latin *nodus,* knot.

L

LAC, a resinous substance found on several kinds of trees in the East Indies. It is caused by the bites or stings of an insect something like the COCHINEAL insect. These insects live on the sap of the trees, and soon become glued to the branches by the juices which ooze out. In time they die, leaving many eggs to be hatched into like insects, which continue the work of their parents until the twigs of the tree are covered with a thick coating of the resin. The sap which they eat gives a purple-red tinge to the whole body, which does not decay when the insects die, but remains with the gum. When the twigs are well covered, people cut them off and put them into hot water, which melts off the gum. It is then purified by straining through bags and dried on strips of wood. This is called "shell-lac." "Seed-lac" is small bits of lac shaken from the trees by various causes, and "stick-lac" is the twigs as they are gathered, but broken up into little pieces.

When the twigs containing the lac are soaked in hot water, the coloring matter in the bodies of the dead insects is washed out. After the melted lac is taken out, the colored water is strained and evaporated, and the purple sediment or dregs is cut up into small cakes and sold as "lac-dye." Great quantities of this are used in dyeing scarlet cloths, for which it is found to be better than cochineal, because the color is not so much changed by perspiration. For this reason, the cloths of which the coats worn by British soldiers are made are dyed with it.

The lac resins are used for making VARNISHES, polishes, LACQUERS, and SEALING-WAX. French polish, much used on furniture, is made of shell-lac and alcohol. Lac is brought mostly from India, Burmah, and Siam.

The word lac is from the Persian *lak*.

LACE. The thread of lace may be of silk, wool, linen, cotton, silver, or gold. The finest kinds of lace are made upon a pillow or cushion. The pattern is drawn on a piece of stiff PARCHMENT pricked full of holes; the parchment is laid on the pillow and pins are stuck into the holes, thus fastening the pattern to it. Bobbins or spools filled with fine thread are arranged around the cushion so that the threads can be twisted round the pins. The bobbins are taken up one after the other and passed across the pillow from right to left, and then back again, twisting the thread around the pins according to the pattern, so as to form the kind of net-work always seen in pillow lace. Among the principal pillow laces are those called Valenciennes, Honiton, Mechlin, Antwerp, Brussels, Chantilly, Lisle, Spanish, and Limerick.

Another kind of laces are those called guipure, which include the various point laces, such as Point d'Alençon, Brussels Point, Venetian Point, Rose Point, Maltese Point, and Portuguese Point. Most of these are ancient laces, and are to be seen only in museums, but the two first named are still made. They are not made on a pillow, but are all needle work, each part of the pattern being worked separately on

a piece of fine linen called the foundation, and afterward joined together by threads.

Great quantities of lace are now made by machinery, on the lace-frame. Such laces, which are usually called bobbin-net, are often of great beauty, and are so cheap that they may be worn by everybody. In making plain bobbin-net, warp threads are used and woof threads (see CLOTH) are twisted round them, so as to form a mesh. The patterns are sometimes woven in by the machine, and sometimes hand-made ornaments are put on to a machine-made net.

The word lace is from the Latin *laqueus*, a noose or net.

LACQUER, a varnish made of shell-lac and other things, dissolved in alcohol, and used mostly for coating metals, chiefly polished brass, to which it gives a golden tint.

Chinese and Japanese lacquer is made from the juice of the varnish tree, a kind of SUMAC which grows in their countries. The sap, which is collected from May to October with a kind of spoon from cuts in the bark, is at first a grayish white liquid, which soon turns yellow, and then black, from contact with the air. It is strained through a cotton cloth, then put into a large circular vessel and stirred for five or six hours, while the heat of a charcoal furnace is thrown on the surface to drive off the water. During the stirring iron dust is added to make black lacquer. Colors, too, are sometimes added, such as vermilion for red lacquer, and sometimes gold dust is mixed with it.

Lacquer gives a harder surface to wood than the best copal varnish, and takes a fine polish which lasts for centuries. It is proof against boiling water or alcohol, and is not hurt by many things that destroy varnish. Lacquered ware is often inlaid with mother-of-pearl and with designs made of gold. Some of it is very costly, bringing high prices even in Japan and China.

The word lacquer is made from LAC.

LADY-BIRD, or **LADY-BUG.** This little insect is usually red, orange, or yellow, with black spots, or black with white, yellow, or red spots. It lays little yellow eggs in clusters on the leaves and twigs of plants, among the plant lice, on which both the larvæ or grubs and the full-grown insects feed. After living about two weeks as grubs they fasten themselves to a leaf, spin a cocoon, and become pupæ (see INSECTS), and in a fortnight more come out as lady-birds.

In old times the lady-bird was believed to live in the sun, and the German children still have a rhyme telling it to fly away up to heaven

Lady-Bird.
1, Perfect Insect; 2, Larva; 3, Pupæ.

and bring back the sunshine; and they believe that if they were to kill one of these insects the sun would not shine the next day. The English rhyme,

> Lady-bird, lady-bird, fly away home,
> Your house is on fire, your children will burn,

probably refers to the same belief: the lady-bird's house being the sun. In Westphalia, Germany, little girls set a lady-bird on the end of their forefinger and ask it in rhyme when they will be married; in one year? two years? three years? etc.; and they grow very impatient if the insect lets them count too high before it flies away.

The lady-bird belongs to the order *coleoptera*, or sheath-winged INSECTS.

The lady-bird is so-called because in old times it was dedicated to Our Lady, or the Virgin Mary.

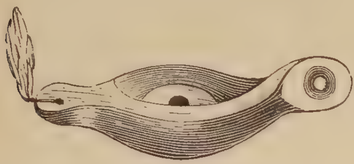
LAKE DWELLINGS. It is supposed that the first men on earth lived in holes in the rocks and CAVES, but when man became more civilized he began to build habitations better suited to his wants. Among the earliest dwellings were those built on platforms in lakes, where those living in them were safe from the attacks of wild beasts and of enemies. These have been found in various parts of the world, but those best known are in the lakes of Switzerland, where their remains and the rubbish heaps under them have been so carefully explored by scientific men that we know exactly how the people who inhabited them lived. Some of the platforms on which the houses stood were built in the smaller lakes, on a foundation of bundles of faggots, stones, and clay piled up and kept in place by a few piles or stakes driven around them. But in the larger lakes they were generally on piles driven deep into the mud, so as to leave their tops four to six feet above the water. These were joined on top by cross beams pinned together with wooden pins, forming a platform on which were built houses with wattled sides plastered with clay, and thatched or bark-covered roofs. A door for entrance opened on the platform and a trapdoor through the floor let the rubbish be thrown into the water beneath. The platform was connected with the shore by a narrow bridge and usually had a drawbridge for safety.

More than 200 lake villages have been found in Switzerland, forty in the lake of Neufchatel alone. Generally, each village had about 300 houses or huts, which shows that a large population lived there at the time. The platform of the village in the lake at Robenhausen, near Zürich, covered nearly three acres and was supported by 100,000 piles. It is supposed that these lake houses were first built in the Stone AGE, and that men continued to live in some of them almost down to historic times. Many kinds of bone, flint, and wooden implements have been found in the rubbish heaps under some of them, showing that those who lived there had not yet advanced beyond the Stone Age in civilization. This is true of most of those in the eastern part of Switzerland, but in those in western Switzerland have been found things belonging to the Bronze Age, and a few things that go to show that they were lived in until the beginning of the Iron Age and almost up to the time of the Roman occupation of the country, in the first century after Christ.

The lake dwellers were small men, but of what race is not known. They lived chiefly by hunting and fishing, though they cultivated wheat, barley, and flax. They had tamed most of the animals which man now uses—the dog, the goat, the sheep, the pig, the ox, and perhaps the horse, bones of all of which have been found; but there are no signs to show that they knew the ass, the cat, the rat, the mouse, or the fowl. They clothed themselves in skins and in woven linen stuffs, but woollen stuffs were unknown to them. They made baskets, ropes, and pottery, though they did not have the potters' wheel, and, from the amber beads, coral necklaces, and jade ornaments found, they seem to have carried on trade with peoples on the Baltic and Mediterranean.

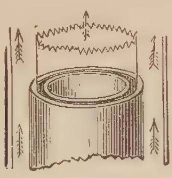
Remains of lake dwellings have been found also in Ireland, Scotland, France, Italy, Denmark, Austria, and other parts of Europe; and modern ones, built much like the ancient ones, are still to be seen in New Guinea and in various parts of Oceanica and Africa. (See C. P. P., SWITZERLAND.)

LAMP. In old times lamps were simple flat vessels, round or oval, with a handle at one end, a kind of spout with a hole for the wick at the other end, and a larger hole in the top to pour oil in. This kind



Ancient Lamp.

of lamp, shown in the picture, was used by the Greeks, Romans, and other ancient peoples. The wicks were sometimes made of tow and sometimes of rushes. This same kind of lamp is still used among the French people of Canada. Its light is dim and smoky, because its wick is so close that the oxygen of the air cannot get at the carbon until much of it has passed off as soot (see FIRE). A little more than a hundred years ago lamps were made in Germany with flat braided wicks, which were moved up and down by turning a



B

A

Argand Burner.
A, Top View ; B, Side View.

little screw, much like those in kerosene lamps. As such a wick has a broader surface, more air can reach it and the carbon can thus get more oxygen. Soon after, a Frenchman named Argand found out how to fit lamps with round wicks, so that the air could get to both the inside and the outside of the wick. This made a much brighter light than was before known, because the carbon of the oil could thus get still more oxygen than before ; but he made it better by adding a chimney to the lamp, which causes a draught of air to pass up the middle of the wick, and also keeps the flame steady. In A, which shows the burner cut across, the outer white circle is the glass chimney, the inner dark circle the wick, and the round dark spot in the middle the hollow inside up which the air comes. The air also comes up in the wide white space between the chimney and the wick. In B is given a side view of the same, the arrows showing the way the air comes up and brings oxygen to the flame.

A great many different kinds of lamps have been made, some of which are simple, while others have so much machinery about them that they are apt to get out of order. In old times vegetable oils, such as olive oil and linseed oil, were mostly burned in lamps ; afterward lard oil and whale and other fish oils were used ; and when whale oil became scarce, camphene and burning fluid, made out of alcohol and turpentine, came into use ; but when PETROLEUM was found out, kerosene oil took the place of all other things for burning in lamps. Lamps are not as much used now as formerly, as GAS gives a much better light, and is much cleaner and less troublesome ; but lamp light is better for the eyes, because it does not flicker so much.

The **Safety-Lamp** or miner's lamp is of great use in mining. Dreadful accidents often happen in coal mines from the explosion or blowing up of a kind of gas called fire-damp. When this gas gets mixed with common air it will blow

up as easily as gunpowder and kill everybody near it. As coal mines are usually underground and dark, the miners have to work by the light of lamps and candles, and before safety-lamps were made many accidents took place from the gas taking fire from the miners' lights. The safety-lamp is only a common lamp set into a kind of lantern of wire gauze. Air will past through wire gauze, but flame cannot. If you hold a piece of iron wire gauze over a gas burner and turn on the gas, the gas will pass through so that you may light it on the upper side. Then move the gauze several inches above the burner, and you will see that the flame will not pass through the gauze. This is because the gauze takes away the heat so quickly that the gas will no longer burn. In the same way fire-damp can go through the gauze of the safety-lamp and burn on the inside, but the flame cannot get to the outside; and so the miner who works by the light of such a lamp is safe from fire-damp explosions. The electric safety-lamp, which is simply an incandescent light in a glass bulb (see ELECTRICITY), is now much used by miners; and many mines are lighted by electric lights, so that safety lamps are not needed.

The word lamp is from the Greek *lampas*, lamp, from *lampein*, to shine.

LAMP-BLACK, a kind of soot made by burning resin, coal tar, pitch, and other such substances in close iron vessels. These give off a dense smoke, which passes off into a chamber covered with a coarse woollen cloth. The lamp-black forms a thick coating on this cloth, from which it is shaken off and put up in barrels for sale.

Printer's INK, BLACKING, and black paint are made from lamp-black. Other kinds of black paint are also made from soot: Spanish black from the soot of burnt cork; bone and ivory black from burnt BONE and ivory; vine black from burnt vine tendrils; and peach black from burnt peach kernels.

Lamp-black is so called because it was formerly made from the smoke of a lamp.

LAMPREY, a kind of fish shaped like an eel, and sometimes called lamprey-eel. The common European lamprey, found from the Mediterranean to the Arctic seas, is about three feet long, and yellowish marked with brown. Lampreys live near the bottom of rivers, where they fasten themselves to stones by the tongue, which acts as a sucker. They sometimes attach themselves in the same way to other fishes and devour them. They go up rivers to spawn in the spring, when great numbers of them are caught, as they are very good eating.

The common American lamprey, found near the mouths of rivers in New England and New York, is olive brown above with black patches, and grows about two and a half feet long. It lives in shallow streams with pebbly bottoms, in which it builds round nests, three or four feet wide and a foot or more high, of stones collected with its mouth. Lampreys go up high falls by darting upward and clinging to the rocks with their mouths.

Lamprey means lick-rock. It is in Anglo-Saxon *lamprede*, from the middle Latin *lampreda* or *lampetra*, from Latin *lambere*, to lick, and *petra*, rock.

LAPIS LAZULI, a mineral of a beautiful sky-blue color, much used for ornament. It is made up chiefly of silica (see SILICON), alumina (ALUMINUM oxide), and soda, with some soda and iron. It is found mostly in Persia, China, and Siberia, but some is brought from Chili and California. Lapis lazuli is used in jewelry, and is carved into vases, cups, and other ornaments. In one of the palaces in St. Petersburg are rooms lined with it. It was once used for making the blue paint called

ultramarine, which was very costly, but is now made cheaply by the ton by mixing together the things of which the stone is made up.

The name lapis lazuli is from the Latin *lapis*, stone, and the Persian *lazur*, blue.

LARCH, a cone-bearing tree of the same family with the pine. It grows in Europe, Asia, and America. The American larch is called hackmatack in New England and tamarack in the South and West. It sometimes grows as high as a four-story house, but is usually much smaller. Its wood is very heavy, strong, and lasting, and is much used for ship building and for railway ties. Its bark is used for tanning leather.

The word larch is from the Latin and Greek *larix*, the larch tree.

LARK. The only lark in the United States is the American sky lark, a pinkish-brown bird, with black tail feathers, and yellow chin and throat. It lays four or five gray eggs, speckled with pale blue and brown. The song of the male bird when on the wing is very sweet. This bird is found all over North America from Labrador to the Southern United States. It is not the same as the European skylark, so celebrated by the poets for its song.

The lark belongs to the order *insessores*, or perching BIRDS, and to the same family with the sparrow and linnet.

The word lark is a short form of *laverock*, from the Anglo-Saxon *laferce*, lark.

LATH, the name of thin, narrow slips of wood, nailed to the uprights of partition walls and to the rafters of ceilings, to receive the plaster, which by being pressed into the cracks is held firmly when it dries. Laths are now mostly sawn by machinery, in steam saw-mills, from refuse pieces of pine, hemlock, and other lumber, which would otherwise be wasted. Roofing laths are larger strips of wood, nailed across rafters to make a bed to nail shingles on.

The word lath is from the Anglo-Saxon *lattu*, a rod or staff.

LATHE, or **TURNING-LATHE**, a machine tool for cutting articles of wood, metal, etc., into round or oval shapes. The way it is made will be best understood by the picture (Fig. 1). It has a solid frame, F, made usually of heavy wood, but sometimes of iron, under which is a fly-wheel, A, turned by the treadle, T, which is worked by the foot like the treadle of a sewing-machine. A strap which passes round the fly-wheel connects it with the pulley, P, and causes the pulley, which is fixed to its axle, B, to turn round very fast. At the other end of the frame is the puppet, H, which can be moved along the slit in the top of the frame and fastened tight in any place by screwing up the nut, X, beneath it. The point, E, can be pushed toward B or drawn back by turning the handle, K, which works a screw passing through the puppet. The axle, B, which is properly called a mandrel, has a screw on its end on which is usually screwed a piece of iron called a chuck, to hold the wood tight. There are many kinds of chucks, but the simplest is that shown in Fig. 2. This chuck is in two parts: *a* screws on to the mandrel B, and the prong *b* sets into the square hole in its end. The piece of wood to be turned is placed between B and E, after the chuck has been put on, and the handle K turned until it is held firmly. The prongs of *b* are thus pressed into the wood so that it must turn round with the mandrel. The point E, which holds the other end of the wood, does not turn round itself, but lets the wood turn round on it. The rest, C, may also be moved along the slit in the frame to any place wanted, and fastened tightly by means of the nut, O.

The wood to be turned having been fastened in place between B

and E, the workman works the treadle with his foot and sets the fly-wheel going. This turns the pulley, P, and the mandrel B, and the wood, being held firmly by the chuck, is also turned round very rapidly. The workman rests his CHISEL or gouge on the rest, C, and holds it firmly against the wood, which turns round against it; thin shavings are thus pared off round and round the wood until it is cut into the shape wanted. A steady arm and hand and much care are needed for turning, especially when hard wood or metals are to be cut. Many kinds of tools are used, but chiefly chisels and gouges. All the rounded parts of furniture, such as the legs of tables, chairs, and stools, the balusters of staircases, tool handles, round rulers, boys' peg-tops, and a vast number of other things are made on the lathe. Not only round things, but irregular forms, such as the stocks of guns and pistols, and

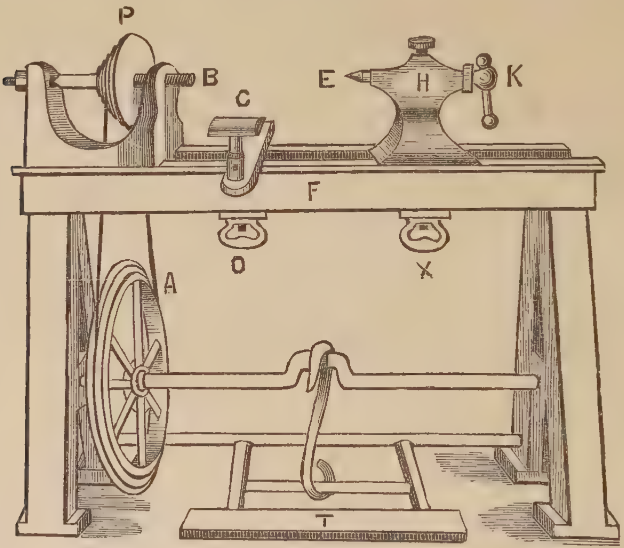


Fig. 1.—Turning-Lathe.

shoe lasts, and hollow things, such as wooden bowls and dishes, bread platters, and boxes, are easily turned. Billiard balls and chessmen are turned out of ivory, and all the round parts of engines and other machines are made on various kinds of lathes. Lathes for machine work are much larger and have more parts to them than the common wood lathes, and they are usually worked by steam. On such lathes, some of which are more than fifty feet long, the great shafts of steamships are turned round and smooth. Another kind of lathe is used by jewellers for engraving the patterns on watch cases, and a like one is used by bank-note engravers for engraving the designs on the counters and backs of BANK-NOTES.

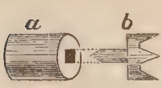


Fig. 2.—Chuck.

LAUREL, a name given to several kinds of shrubs, mostly growing in hot countries. The true laurel, called the noble laurel, belongs in the

south of Europe, where it sometimes grows as tall as a high house. It is an evergreen, with beautiful glossy leaves, and bears black berries about the size of wild cherries. This is the laurel used for crowns, and the custom of crowning poets with it gave rise to the title poet laureate (Latin *laureatus*, crowned with laurel). It is sometimes called the sweet bay tree, and its fruit the bayberry (from French *baie*, Latin *bacca*, a berry). The word baccalaureate (from Latin *bacca lauri*, laurel berry), meaning the degree of bachelor of arts, the lowest degree given in a college, also comes from this, because bachelors of arts used to wear a wreath of bays or bayberries when they were given their degree. Laurel or bay leaves are used for flavoring in cookery, and also to pack round figs in their boxes to keep insects from them.

The **American Laurel** is not a true laurel, but is rightly called kalmia, having been named after Peter Kalm, a Swedish botanist, who travelled in this country in the last century (1748–1751), and wrote a book about American plants. The kalmia, which is found almost all over the United States, grows commonly on rocky hillsides. It is a shrub, sometimes two or three times as high as a man, has thick bright green leaves, and bears bunches of beautiful pink and white flowers. The wood is hard and has a fine grain, and is used by turners for making tool handles, and by carvers for making wooden spoons. Its roots are used for making rustic seats, flower-stands, etc.

The word laurel is from the Latin *laurus*, the bay tree, laurel.

LAVA, the melted matter which runs out of volcanoes. It flows like melted glass or iron, and is sometimes solid and very hard after cooling, and sometimes light and full of little holes like PUMICE-stone. Lava is sometimes made into ornaments, by pressing it when melted into moulds; but the most of the common lava ornaments are made out of IRON slag, or the glassy matter which flows from smelting furnaces. Very handsome vases, brooches, and other things are made out of it.

The word lava is Italian, and means a flood of rushing water, from the Latin *lavare*, to wash; and the name is given to the matter flowing from a volcano, because it is like a water flood.

LAVENDER, a fragrant plant much used in making perfumes and in medicine. Oil of lavender is made by distilling (see ALCOHOL) the flowers of lavender with water; and spirit of lavender by distilling them with alcohol. Lavender-water is made of oil of lavender, spirit, and rose-water.

The word lavender is from the Latin *lavare*, to wash, and the plant was so called because used in bathing and washing.

LEAD, a METAL, and one of the principal ELEMENTS. When pure it is bluish gray, very heavy, can be easily melted and cut, and may be hammered out into sheets and drawn into wire. When left in the air it oxidizes or rusts slightly so as to form a thin coating on its surface, which keeps it from further change. For this reason it is used for water pipes and cisterns, and for covering the roofs and gutters of houses. But many kinds of water corrode or eat lead, and take up from it a kind of poison which makes lead pipes dangerous to use.

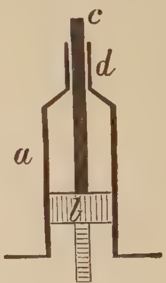
Lead Ore. Most of the lead used in the arts is made by smelting in furnaces the ore called galena (lead sulphide), which is made up of lead and SULPHUR. Though made up mostly of lead and sulphur, it generally has some silver in it, and also a little ANTIMONY, ARSENIC, copper, iron, and zinc. Galena ore is found in many parts of the world, but the purest is in the United States, England, and Spain. There are celebrated mines of it in Saxony, Bo-

hemia, and in the Hartz Mountains in Germany, but the ore from them is mixed with other metals, especially with silver. The chief galena mines in the United States are in Wisconsin, Illinois, Iowa, and Missouri; the most ore being got in the country around Galena, Illinois.

Smelting. The smelting or melting of the galena ore to get the pure lead out of it is done in a furnace different from that used in smelting IRON. The ore is first roasted or heated, which drives off some of the sulphur and other impurities, and is then put into a square furnace, which has a pipe called a *tuyère* opening into it behind, through which a blast of air is blown, and an opening at the lower part of the front where the melted metal can run out. The fuel, which is either wood or charcoal, is put in with the ore in layers, and the furnace is kept going all the time. As the lead melts, it is drawn off at the bottom and run into moulds which make it into small blocks called "pigs." Lead smelting is very unheathful, as the fumes or vapors are poisonous, and all the grass and other plants around the furnaces are killed.

Sheet Lead is now made by rolling slabs of lead between heavy iron rollers until they are brought down to the right thinness. This is called "milling" the lead. The slabs sometimes go through the rollers two or three hundred times, each one being cut up into pieces as it gets too long to be easily handled. Sheet lead is made of many thicknesses, which are known by numbers, each number meaning the number of pounds in a square foot of the sheet. Thick sheets are used for lining tanks and water-cisterns, and for covering roofs, and thin sheets for wrapping up snuff, lining tea-chests, etc. The Chinese make much lead for tea-chests by pouring melted lead on a flat slab, and then putting another flat stone on top of it, thus pressing it out thin; but they get most of their sheet lead now from England.

Lead Pipe used to be made by casting a short pipe of the right size inside, but much thicker than is needed. An iron rod, called a mandrel, of the size of the inside, was then put into it, and the pipe was rolled out until it was of the thickness wanted. But pipes only twenty or thirty feet long could be made in this way, and lead pipe is now commonly made by means of a hydrostatic press (see WATER), which forces melted lead up through tubes of the right size. The press, which is under the floor of the room where the pipe is made, pushes a piston up through a strong metal cylinder or barrel filled with melted lead. On the top of the cylinder is a steel tube of the size of the outside of the pipe wanted, and through this is pushed a mandrel which is fastened to the piston, and which is of the size of the inside of the pipe. This may be understood better from the picture, where *a* is the metal cylinder, *b* the piston, *c* the mandrel fastened to the piston, and *d* the steel tube.



Making Lead Pipe.

The cylinder, which is kept hot all the time, is filled with melted lead through a spout in the top. The spout is then closed, and the press below pushes up the piston, thus forcing the lead through the round space between the die and the mandrel. As the lead comes out at the

top it cools in the form of a pipe, and is wound round a drum or barrel above. This is why lead pipe usually comes coiled round in rolls.

Uses of Lead. Lead is used not only alone, but also in ALLOY with other metals. When mixed with ARSENIC it forms the alloy from which SHOT are made; with TIN, PEWTER and SOLDER; and with ANTIMONY, TYPE metal. Among the most useful compounds of lead are white lead (lead carbonate), made up of lead and CARBONIC ACID, much used for making white paint; red lead (red lead oxide), made up of lead and OXYGEN, used for making red paint; litharge (yellow lead oxide), made up also of lead and oxygen, used in GLASS making; sugar of lead (lead acetate), made up of lead and acetic ACID, used in calico printing; and chrome yellow (lead chromate), made up of lead and chromic acid, used for making yellow paint.

The word lead is Anglo-Saxon.

LEAGUE, a measure of length or distance used chiefly for estimating distances at sea. The nautical or marine league of England and the United States is equal to one twentieth of a degree at the equator, or three nautical miles, which are equal to 3.457875 statute miles. The German league contains four geographical miles, or about 4.6 English statute miles.

The league is used also as a land measure, differing in length in different countries. In England it equals three statute miles, and in France from 2.42 to 2.77 English statute miles, according to usage.

The word league is from the old French *legue*, from the low Latin *leuga*, or *leuca*, from the Gaelic *leac*, a flat stone, because such stones were used for milestones.

LEATHER. The hide or skin of an animal, which is called a pelt before it is made into leather, is formed of two parts, the epidermis, or cuticle, in which the hair grows, and the dermis, or cutis, which lies under the cuticle and next to the flesh. The cutis is made up of many little fibres or threads which cross each other in all directions, the spaces between being filled with GELATINE, which keeps the skin soft and flexible while the animal is living. The fibres themselves are also mostly gelatine. When the skin is first taken off an animal it is soft and easily stretched, but as soon as it dries it shrinks and the gelatine in it becomes hard and horny; if, too, it is put into water, the water will soak into it and the gelatine will soon begin to decay and to smell bad. But if all the fatty and fleshy matter be scraped off the skin, and it be soaked in certain liquids containing tannin, or tannic ACID, the gelatine in the skin will separate all the tannin from the liquid and unite with it, forming leather.

Hides to be tanned, that is, made into leather, are first soaked in water about two weeks; after which they are soaked in deep square holes called vats, filled with lime water, for several days more, to loosen the hairs. They are next scraped on both sides, on the upper side to get off the hair or wool, and on the lower to remove any pieces of flesh or fat that may still be left. The next thing is to get out the lime. This is done by soaking the hides in a mixture made usually of hen dung and water, for about a week, which takes out the lime and makes the skins soft and pliant. They are now ready for tanning, which means soaking them in a mixture of tanbark and water for four or five months, during which time they are frequently changed from one vat to another. The best tan is made from oak or hemlock bark, though other kinds are sometimes used. In the United States hemlock is most used. The bark is ground up in a bark mill, and the tannin is then got out of it with either hot or cold water. There are many different ways of

making leather, but the object in all is the same—to make the tannin of the bark unite with the gelatine of the hide.

When the hides are tanned enough, they are taken out of the vats, washed, drained, and dried in lofts, after which they are hardened by being hammered or rolled under heavy rollers. Sometimes thick skins are split into two by a knife working by machinery, which divides them evenly and smoothly. The upper or hair side of a split skin is better than the under side, which is used only for the cheaper kinds of work. Thin skins are treated somewhat differently from thick ones, but the principle is the same. Calf skins and other upper leathers are rubbed with oil and tallow to make them soft, and then blackened with oil, lamp-black, and tallow.

Patent Leather. Skins for making patent leather are first tacked on to frames and covered with several coatings of linseed oil and umber (see PAINTS), mixed with a little LAMP-BLACK, and then varnished several times with a varnish made of linseed oil and Prussian blue, thinned with spirits of turpentine. The leather is scraped and smoothed with pumice-stone, and is then dried in ovens heated as hot as it will bear. Enamelled leather, used for carriage tops, is made in nearly the same way, only a thinner coating is put on, so that the grain of the leather shows.

Russia Leather, noted for its pleasant smell, is tanned with willow bark, which has but little tannin in it and therefore tans it very slowly. It is then treated with birch bark tar, but in what way is not exactly known. Moths and other insects do not like the scent of Russia leather and will not eat books that are bound with it.

Morocco Leather is so called because it was first brought from Morocco. It is mostly made from goat's skins but a cheap kind is made out of sheep skins. After the skins have been cleaned each one is sewed up by its edges into the form of a bag, the hair side being on the outside. A strong mixture of SUMACH and water is then put into it, and it is blown full of air and sewn up. About fifty such skins are thrown into a large tub of hot sumach liquor, and left to float a few hours, after which they are unsewn, scraped, and dried. They are colored with different things: red morocco with COCHINEAL; yellow with BARBERRY root; blue with INDIGO, etc. Much morocco is now made in France and in the United States. It is largely used for covering chairs and sofas, for lining coaches, for bookbinding, and for making pocket-books.

Kid Leather is used for the finest gloves and ladies' shoes. Lamb skin is also much used for gloves, most of those called dog-skin gloves being made from it. What is called chamois or shamoy leather is made mostly from sheep, goat, and deer skins. Sheepskin is also largely used for bookbinding, and for many other purposes. Hogskin is used for covering saddles, horse hide for harnesses, collars, etc., and cowhide for sides of boots and shoes. The tops of fine boots and shoes for men are mostly made of calves' skin. A fine leather is made from sealskin, and the skins of young alligators are sometimes tanned for boots and shoes.

Leather scraps are now ground up and mixed with certain fluids until they are made into a kind of pulp or paste. This paste is pressed into moulds of different shapes, and when dry is hard and tough. Many useful articles are thus made, among which are door knobs, canes, combs, cups, and buttons.

The word leather is from the Anglo-Saxon *lether*.

LEEK. See ONION.

LEMMING, a small animal belonging to the mouse family, living in the Arctic regions. The common Euro-

pean lemming, which lives in Norway, Sweden, and Lapland, is about five inches long, tawny-brown above, with black markings, and yellowish-white below. They are so numerous in the mountains that they sometimes come down in great armies, eating every green thing in their course. They travel by night or early in the morning, moving in a straight line, swimming rivers, crossing mountains, and all other things in their way. Wild animals and birds of prey follow them and live upon them, and many are finally drowned in the sea. In old times the peasants of Norway used to think they came from the clouds, and the priests would try to drive them away by prayers.

The word lemming is Swedish, and means destroying.

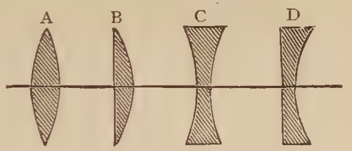
LEMON, the fruit of a tree belonging to the same family with the ORANGE, lime, CITRON, and SHADDOCK. The lemon grows wild in Southern Asia, and is cultivated all around the Mediterranean Sea and in the West Indies and other warm parts of America. The tree is much like the orange tree, and is grown in the same way. There are about thirty kinds, which differ mostly in the shape, size, roughness, and thickness of skin of the fruit. One kind, which grows in Southern Europe, has sweet juice, but all the rest are very sour, the juice containing much citric acid. The lemons we buy come mostly from Sicily, but fine ones are raised in Florida and California.

The juice of lemons is used for cooling drinks and as a medicine in cases of fever, scurvy, etc. It is also used by calico printers to make clear the white parts of patterns in cloths dyed with dyes which have iron in them. Citric acid and lemon syrup are made from it. The oil of lemons, pressed out of the outside part of the rind, is used by cooks, confectioners, and perfumers. Extract of lemon is made by mixing this oil with alcohol. Salt of lemons, used for taking out ink spots, has no lemon in it, but is made from oxalic acid and potash.

The **Lime,** which is like a small lemon in shape and is also like it in the sourness of its juice, grows wild in the West Indies, where it is used as a hedge plant. Its uses are the same as those of the lemon. A sweet lime grows in the south of Europe.

The word lemon is from the Arabic *laimûn*, lemon.

LENS. In the article LIGHT (Fig. 5) is given the picture of a convex lens, or one rounded outward on both sides. Such a lens, shown also in A, is called, therefore, a double-convex lens. A lens which is con-



Lenses.

vex on one side and plane or flat on the other, as in B, is called a plano-convex lens; one like C, which is concave, or rounded inward, on both sides, a double-concave lens; and one plane on one side and concave on the other, as in D, a plano-concave lens.

Lenses are usually made of thick, flat pieces of glass ground down into the shape wanted by means of a grinding powder of sand or EMERY, and afterward polished with a softer powder. The greatest care is needed in grinding and polishing lenses for telescopes and microscopes, as the least unevenness in the surface would spoil them. Lenses for such instruments are made of the best crown or flint glass, and it is very hard to make large pieces of glass perfect enough for the purpose.

Lenses have many uses. The common burning-glass is a double-convex lens, which brings the sun's

rays to a point, as told about in LIGHT (page 432). As these rays contain heat also, the heat is thus brought to a point and made to burn anything which is placed where the point falls. Convex lenses are used for making eye-glasses and spectacles for far-sighted persons, and singly as magnifying glasses. Concave lenses are used in spectacles by near-sighted persons. Various lenses are used in making opera-glasses, MICROSCOPES, STEREOSCOPES, TELESCOPES, and other like instruments.

The word lens is from the Latin *lens*, a lentil seed, which is much like the shape of a convex lens.

LEOPARD. An animal found wild in Africa and in India. It is usually about the size of a very large dog, but is shaped more like a cat, and has a tail nearly as long as its body. Its fur is tawny yellow, beautifully spotted with black. The leopard is a very active and graceful animal. It lives mostly in thick forests, feeding upon antelopes, deer, and smaller animals, but sometimes comes around farms to steal pigs and poultry. It is a good climber, and often chases monkeys into the tops of trees. Some think that the leopard and the PANTHER are only different kinds of the same animal.

The African **Hunting Leopard,** or *cheetah*, looks like both a dog and a cat, and is sometimes called the dog-cat. It is trained to chase other animals like a hound. Another kind in Asia is used for the same purpose. These leopards are blindfolded and led to the hunting-field by a chain, just as greyhounds are. When an animal is seen their eyes are uncovered and they are let go, and they very soon catch the game and suck its blood, but leave the body for their master. These animals are very tame, and live in families like common cats.

The leopard is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the cat family, to which belong also the LION, TIGER, PANTHER, COUGUAR, JAGUAR, LYNX, and common CAT.

The word leopard is from the Latin *leo*, lion, and *pardus*, panther.

LETTUCE, a common plant, the leaves of which are much used for salad. There are many kinds, divided into two different sorts, called cos lettuce, which does not grow in heads, and cabbage lettuce, which forms heads like a cabbage. Lettuce is worth very little for food, but is easy of digestion. A kind of opium called *lactucarium*, is made from its juice, and used in medicine. Wild lettuce grows in the countries around the Mediterranean, and in the north of India. The Greeks and Romans used it for salad, but it is doubtful if the Hebrews knew it.

The word lettuce is from the Latin *lactuca*, which is from *lac*, milk, the plant having a milky juice.

LEVEL. When the surface of anything is parallel to that of still water or perpendicular to the direction of the plumb line, it is said to be level; and an instrument for finding out when a thing is level is commonly called a level. A plumb-line is a line or cord to one end of which is fastened a metal weight, usually of lead (Latin *plumbum*). When held by the other end the weight or plummet will point to the centre of the earth, the same direction in which bodies fall when attracted by gravitation (see EARTH). The simplest instrument for finding a level is the **Plummet Level,** a wooden frame shaped some like an inverted ⊥, with a plumb-line attached to the upright. When the line shows that the upright is exactly perpendicular, the lower or horizontal limb, which is at right angles to it, will be level. This is used by bricklayers, masons, and carpenters.

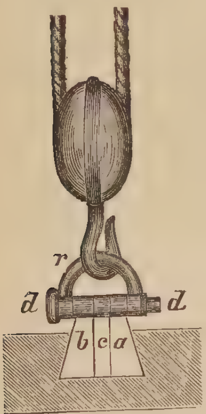
The **Spirit Level** is a frame with a glass tube, closed at the ends, and nearly filled with ether, or a mixture of ether and alcohol, leaving a small bubble of air inside. When the instrument is level the bubble of air

will be exactly in the middle of the tube. This kind of level has now largely taken the place of the plumb-line level, which is used only for coarse work.

The **Surveyor's Level** is a telescope with a spirit level attached, and mounted upon a tripod. It is used for measuring differences in heights.

The word level is from the Latin *libella*, a balance, diminutive of *libra*, balance, level.

LEWIS, an iron clamp made to fit into a hole cut in a stone, to raise it by. It form will be best understood from the picture, where the lewis is shown fitted into its place. When the stone has been raised to the place wanted, the rope and pulley are unhooked from the half-ring *r*, and the bolt *d d* is driven out; the part *c*, may then be drawn up, and this lets out the parts *b a*. The lewis is then ready to be put into another stone, being set in the parts *b a* first, and the part *c* then driven in, which holds them in place.



Lewis.

The lewis is said by some to have been found out in the time of Louis XIV., and to have been named after him, but it was in use long before.

LICHENS, a kind of plants without separate stems or leaves, which grow on rocks, on the bark of trees, on earth, etc. They are sometimes wrongly called rock moss and tree moss, but they are not MOSSES, which have separate stems and leaves. Lichens have no roots, but live on air, and fasten themselves to almost everything that is dry and moist by turns. The gray, yellow, and brown stains on old walls are made of very small lichens which grow where nothing else can grow. They are found all over the world, in the hottest and in the coldest regions, on the rocks of newly formed islands in the ocean, and on the tops of the highest mountains.

Lichens contain a kind of starch, a bitter substance, a resin, various coloring matters, and a little lime, salt, and iron; and they are of great use to man, both as food and medicine.

They also give rich dyestuffs, such as archil, orchil, or cudbear, which makes red, purple, violet, and lilac dyes, used in dyeing silks. Cudbear (for Cuthbert) is a kind of archil made in a way first found out by Dr. Cuthbert Gordon, who named it after himself. The purple dye called litmus, with which litmus paper, used for testing ACIDS and ALKALIES, is colored, is made from archil.

Iceland Moss, of which blancmange is often made, is a lichen which grows in the most barren parts of Iceland and in other cold countries. It makes a very good food for cattle, sheep, swine, and deer, and the Icelanders make both bread and soup of it. Another lichen, called Mary's grass by the Icelanders, is also much used in the same way. In Lapland and northern Siberia the reindeer lichen covers barren plains where scarcely anything else will grow, and is the chief food of the reindeer. Once when grain was very scarce in Sweden, this lichen was ground up with flour to make bread. Another kind of lichen is found on the great steppes of Asia, and is much used for food by the wandering tribes. It is found in round pieces about as large as filberts, and looks like little stones. The people there think that in falls from heaven. **Tripe de roche** (rock tripe) is the name given to a lichen growing in the northernmost

parts of North America, which the Indians eat, mixed with the roe of fishes.

The word lichen is Latin, and comes from the Greek *leichen*, which means the same as our word.

LICORICE. There are several kinds of licorice plants, some of which grow wild in the countries around the Mediterranean and as far east as China, and one kind in the United States. It has been cultivated in England since the fourteenth century. Licorice is brought to the United States from Asia Minor in the roots, and from Spain and Italy in the form of rolls or sticks made from the juice extracted from the roots, boiled down, and mixed with a little starch to harden it. It is used in the manufacture of chewing tobacco, and by brewers in making porter and ale. It is put also into many medicines for coughs and colds, and in syrups and elixirs, and is used to some extent for chewing.

The word licorice, which means sweet root, is from the Latin *glycyrrhiza*, from the Greek *glukus*, sweet, and *riza*, root.

LIGHT. We do not know exactly what light is, though it is now believed to be a form of ELECTRICITY. It comes to us from luminous (Latin *lumen*, light) bodies, that is, bodies which give out light themselves, such as the sun, the fixed stars, and some meteors, in the heavens, and from burning substances on earth, such as burning wood, gas, tallow, and oil. It is given out also by some animals, such as glowworms and fire-flies, and by the multitudes of little animals in the sea which often make the waves shine and sparkle. When we look at the sun or at the flame of a candle the light from it comes straight into our eyes and makes an image there, and thus we are enabled to see it. The light from every luminous body shines from it in straight lines, each one of which is called a ray of light. If we let a sunbeam shine into a dark room through a little hole in the shutter, the ray will be seen to be straight.

We cannot tell certainly how light comes to us, though most writers think it travels in waves in much the same way that SOUND travels; but it goes much faster than sound. When a cannon is fired off at a distance we see the flash, and some time afterward we hear the sound. We thus know that light and sound do not travel at the same rate, for when we stand near the gun we see the flash and hear the report at the same time. It has been found out in different ways that light travels nearly 200,000 miles (186,000) a second, or more than a million times faster than sound. It therefore takes the light of the sun eight minutes to travel from the sun to the earth. All light travels with the same speed, so that the light of a candle goes just as fast as the light of the sun. Light will also travel a great deal further than sound; we often see lightning so far off that we do not hear its thunder. The light waves and the sound waves start to come to us about the same time, but the thunder cannot pass through the air so fast as the lightning, and it dies away before it reaches us.

We get light also from bodies or things which are not luminous, such as the moon, houses, trees, and persons, but it comes to us in a different way from the light of the sun and the light from fire. They do not give out any light themselves, but the light which shines on them from something else glances off and comes from them into our eyes. When we look at the sun, the light from it comes straight into our eyes, as told above; but when we look at a house, the light goes first to the house from the sun, and then glances from it into our eyes, and thus we are able to see a thing which does not make any light itself. When light glances off in this way it is said to be reflected (Latin *reflectere*, to bend or turn backward). Light is

often reflected a good many times before it reaches our eyes. We can see a tree by moonlight, but we know that neither the tree nor the moon makes any light itself; we say therefore that the light of the sun is reflected by the moon to the tree; and then by the tree to our eyes. If now we hold a mirror in our hand so that we can see the tree in it, the light from the tree will be again reflected or bent out of its course by the mirror.

When you look into a mirror you see an image or picture of your face. This is because the light which strikes your face is reflected from it to the mirror, and is then reflected again from the mirror into your eyes; and the image or picture which the light from your face makes in the mirror is made again, but much smaller, in the back part of your eyes. The image in the glass is an exact copy of your face, only that its right side is your left side,

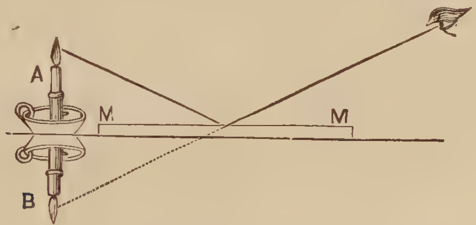


Fig. 1.—Lamp and Mirror.

and its left side your right side. This will be seen better by holding a printed book before a mirror, when all the letters will appear to be turned, so that they will read from right to left instead of from left to right. The image appears to be behind the glass as far as your face is in front of it; if you go closer to the mirror the image comes closer also, and if you draw back the image draws back. If now you lay the mirror down flat with its face upward and place a candle at the further end of it, as shown in the picture, the image of the candle will appear upside down. This is because the ray of light which comes from the candle A to the mirror M M is reflected from the mirror to the eye in just the same way as it would be if it came from a candle upside down, B, as much below the surface of the mirror as the real candle is above it. In the same way the images of houses and trees in water always look upside down. We see them just as if they were under the water instead of above it.

When a slanting ray of light falls on water, glass, ice, or anything through which it can shine, it is bent so as to be less slanting after it enters the water, glass, etc.; and if a ray of light comes out of water glass, etc., into the air, it is bent so as to be more slanting after it enters the air. This is shown in the picture, Fig. 2, where *a b c d* is a ray of light shining through a thick flat piece of glass: *a b* is the ray before it enters the glass; *b c* is the same bent by the glass so as to be less slanting; and *c d* is the same

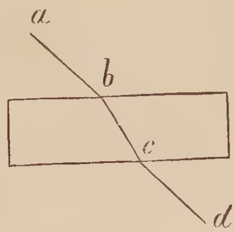


Fig. 2.—Refraction of Light.

after it leaves the glass and enters the air again, having the same slant as it had at first, but in a different line. Light is thus bent out of its straight path only when it passes from one thing into another thing of a different density or thickness, as, for example, from air into water or glass. This bending of a ray of light is called refraction (Latin *refrangere*, to bend or break back, from *re*, back, and *frangere*, to break), and a ray thus bent is said to be refracted. If you put a stick slanting into the water, it will look as if it were bent at the point where it enters the water, and the part under water will look less slanting than the part out of water. This is because the light from the stick is refracted by the water, which is denser or thicker than the air.

Now put a pebble at the bottom of a pitcher close to the side, place your eye so that the side of the pitcher just hides the pebble, and then let some one fill the pitcher with water. The pebble will at once come into view. You have not moved your eye, nor the pitcher, nor the pebble, yet you can now see the pebble plainly. This seems as if you could look round a corner, and it is what you really do for the ray of light which comes from the pebble is refracted after it leaves the water and thus enters your eye.

Fig. 3.—Prism.

It is shown in Fig. 2 that after a ray of light has passed from air through a piece of flat glass into air again, the ray has the same slant after coming out of the glass as it had before it went into the glass, but in a different line. Suppose now that the piece of glass is three-cornered or wedge shaped instead of flat, as shown in Fig. 3. A piece thus shaped is called a prism. A ray of light passed through a prism is bent or refracted in a different way from one passed through a flat piece of glass, as will be seen in Fig. 4, where *a b c* shows a prism cut across; A B is the ray before it enters the prism, B C the ray bent in the prism, and C D the ray after it leaves the prism. It will be seen from this that when

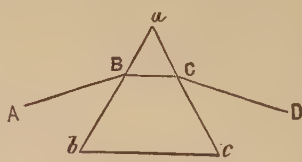


Fig. 4.—Refraction of Light by a Prism.

a ray of light passes through a prism, it is bent after coming out into a different slant from that which it had before it went into the prism, and that this slant is always toward the base or thicker part of the prism.

Next let the ray of light shine through another piece of glass shaped round, and thick in the middle and thin all round the edge, so that when you see it sidewise it looks like the piece in Fig. 5. A piece of glass made into this shape is called a LENS. Now a lens is

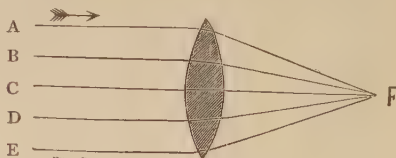


Fig. 5.—Refraction of Light by a Lens.

really a round wedge, and light when passed through it is bent in much the same way as it is when passed through the wedge-shaped prism, that is, it is made to slant toward the thickest part of the wedge. In Fig. 5, A B C D E are several rays of light shining on a lens; after passing through the lens each ray is bent or refracted toward the thickest part of the wedge, and as this thickest part is the middle of the lens all the rays are thus made to slant toward the middle so that

they come to a point, as shown in F. In Fig. 4 is shown how a ray of light is bent in passing through a prism. If we look a little further we shall see that every kind of light is not bent in the same way. The light that comes from the sun is white, but it is in reality a mixture of several different colors, such as we see in the rainbow. When a beam of light is made to pass through a prism, the colors, each of which is bent in a different way after coming out of the prism, are all separated, and we can see each one by itself. We can thus divide light into the different parts of which it is made up. Sir Isaac Newton first found out how to do this. He let a beam of sunlight shine into a dark room through a small hole in a shutter, as shown in Fig. 6, where D E is the beam of light. There was a screen at F, and when the beam of light shone straight through the hole it made a round white spot on the screen. He then placed a prism in the way of the beam so that it would have to pass through it. This bent the light out of its path, and the different colors being bent or refracted in different ways, they were separated, and formed on the screen, instead of a circle, an oblong figure such as is shown in the picture. We see by this that a beam of white light may be divided into seven different colors, violet, indigo, blue, green, yellow, orange, and red. From this we know that sunlight is not a simple thing, but that it is made up of seven colors. We

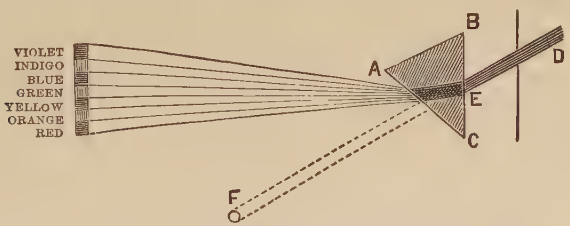


Fig. 6.—Division of Light into its Colors by a Prism.

often see these colors separated in dew-drops, in ice, in diamonds, and in the RAINBOW.

Now, when we look at a blue thing or a red thing, or a thing of any other color, why does it look blue, red, etc., to us? Because when a beam of white light falls on a blue thing it is separated and only the blue rays are reflected to our eyes, while the other six colors are absorbed, that is, they are taken up and kept by it. It is the same with a red thing; it reflects the red rays to our eyes and keeps the other colors; and so with other colors. If we look at a blue or red thing in the dark, we do not see anything. It has color only when the light comes to it. When a thing reflects all the colors it looks white; and when a thing absorbs all the colors it looks black.

The word light is from the Anglo-Saxon *lyht*, bright.

LIGHTHOUSE. The first lights for the guidance of mariners were probably only fires kindled on headlands, or perhaps on towers built for the purpose. The most famous lighthouse of the ancient world was the Pharos of Alexandria, finished about 280 B. C., which was 400 feet high. The fire, always kept burning on its top at night, could be seen forty miles at sea. It got its name from the island of Pharos, on which it was built, and other lighthouses were afterward called by the same name. Even now the French name

for lighthouse is *phare*, and the Spanish and Italian *faro*.

Modern lighthouses are towers built of stone, brick, or iron, with a lantern on top for the light. Until about the middle of the eighteenth century lighthouses were illuminated by wood or coal fires, and afterward by candles and lamps. In the United States oil lamps with Argand burners (see LAMP) are used, with some kind of reflectors. Lard oil is generally burned here, but in Europe sperm oil and vegetable oils, such as olive and rape-seed oil, are preferred. Electric lights have been tried, but they are too costly and their shadows are too deep.

Lighthouses are classed as of the first, second, third, and fourth orders; the first two are coast lighthouses, and the last two those in sounds, harbors, and rivers. Some have fixed, some revolving, some flashing, and some intermittent lights; and some, too, are distinguished by different colors.

LIGHTNING. Dr. Franklin first showed that lightning is the same as the ELECTRICITY made by the electrical machine, as is told about under KITE. As the electricity of the electrical machine is got by rubbing glass, so much of the electricity of the air is caused by the rubbing of moist air against dry air. A great deal is made by the turning into vapor or mist of the salt water of the ocean by the sun's heat or the blowing of the wind. There is more water turned into vapor during the heat of summer and autumn than in winter, and this is the reason why there is more lightning in warm weather than in cold weather. There is always a good deal of electricity in the air, and in clear weather it is generally positive electricity, but during fogs, rains, or snows it is usually negative electricity, though it changes often. Sometimes it happens that two clouds, one charged with positive electricity and the other with negative electricity, come near each other, and then the two kinds of electricity rush together and we see a flash of lightning and hear thunder. The lightning is the same thing as a spark from an electrical machine, the only difference being that a flash of lightning is sometimes several miles long and the spark only a few inches. The little spark which we make gives out only a snapping sound, but if we were able to make a spark as large as a flash of lightning it would make as much noise as thunder. When a cloud filled with one kind of electricity comes near the earth when that is filled with the opposite kind, the cloud may discharge its electricity to the earth. If any tall thing, such as a tree, a steeple, or a house, happen to be near where the cloud discharges, the electricity will often pass down it to the earth. In this way houses are sometimes injured and set on fire, and great trees are split up into small pieces. Sometimes, too, human beings and animals are struck and killed. It is not safe, therefore, to stand under a tree or close to a high house during a thunder-storm.

We see lightning in several different forms: sometimes its flash is straight, sometimes it looks forked or zig-zag, sometimes it is round like a ball, and sometimes it spreads over the clouds like a sheet of fire. When a thunder-cloud is near the earth the flash comes straight down to the earth, because there is but little air for it to pass through, but when the cloud is at a considerable distance from the earth, the air in the path of the lightning is made denser or thicker by being pushed together, and as lightning can pass quicker through thin than through thick air, it flies from side to side so as to pass where the air is thinnest. This makes its path zig-zag or forked. When there is a great charge of electricity in a cloud it sometimes forces its way through the air in the shape of a ball. What is called

sheet lightning is either the reflection or shine on clouds of a stroke of zig-zag lightning, which is too far off to be seen, or light discharges of electricity from clouds which have not enough in them to make zig-zag lightning.

When lightning passes through air it leaves behind it a vacuum, that is, an empty place, and the air rushing in to fill it makes the noise which we call thunder. We do not usually hear this until some time after the flash of lightning, because light travels more than a million times faster than sound. When the thunder-cloud is at a distance, the sound comes to us little by little, and we then call it rolling thunder; but when the cloud is near the earth the sound comes in one great crash. You can generally tell how far off a thunder-cloud is by noting how long the time is between the flash of lightning and the sound of the thunder. If you can count five as slowly as the tick of a clock between the two, you may be sure that the cloud is more than a mile away.

Lightning, in its way to the earth, will always follow the best conductor, and when it strikes a building or a tree it will leap from side to side to find it. It likes pointed things better than round or blunt things, and this is the reason why lightning rods are made with sharp points. Buildings properly fitted with lightning rods are safe from being struck by lightning, because the rods lead off the electricity into the earth. When a cloud filled with electricity comes over the rods, the electricity will flow silently down them until the cloud is discharged, and we see no flash and hear no thunder; but we may feel sure that the building will not be struck. The tops of lightning rods are usually made of silver, or are gilded, so that they will not rust and become worthless. The lower end of the rod must be carried down into damp earth; if the earth is dry it is better to carry the end into a well, because dry earth is not so good a conductor as moist earth, and the lightning might leap from the rod at the lower end and go into the cellar of the building. High chimneys should have rods on them, because the soot in them is a good conductor, as is also the vapor which rises from them when fires are burning.

The word lightning is from lightening, which is from the Anglo-Saxon *lyhting*, lightning.

LIGHTNING-BUG. See FIRE-FLY.

LIGNUM-VITÆ, the wood of the *guaiacum* tree, which grows in the West Indies and Central America. It is very heavy, hard, close grained, and tough; in the middle or heart of the trunk it is greenish brown, while the sapwood, or wood around the heart, is pale yellow. It is used for making rulers, pulleys, the sheaves or wheels in ships' blocks, pestles, and other articles which need to be of a tough material. The resinous juice of the tree, wrongly called gum guaiacum, is used in medicine in cases of rheumatism, skin diseases, etc.

Lignum-vitæ means wood of life, and is from the Latin *lignum*, wood, and *vitæ*, of life.

LILAC, a flowering shrub of the same family with the olive. The common lilac has flowers of a bluish pink, usually called lilac color, but other kinds have white, red, or violet flowers, all being very fragrant. An oil for perfumery is sometimes distilled (ALCOHOL) from them. Lilac wood has a fine grain, and is used for turning and inlaying. The lilac is supposed to have come first from Persia, and was brought to Europe about three hundred years ago.

The word lilac is from the Turkish *leilâk*, lilac.

LILY, a bulbous plant, bearing beautiful flowers, found in both the Old and the New World. Four kinds grow east of the Mississippi River: the yellow Canada lily, found from Canada to Georgia; the south-

ern red, from Kentucky to Florida; the orange-red, and the swamp lily or American Turk's Cap, as far south as Georgia. On the Pacific coast are the Washington lily, with beautiful white flowers; the panther lily; and Humboldt's lily, with yellow, dark-spotted flowers.

The common white lily, sometimes called Madonna lily and Annunciation lily, the lily of poets and painters and the emblem of purity, was brought from the Levant about three hundred years ago. The well-known tiger lily came from China; and the long-flowered and the golden-banded lily from Japan.

The **Calla,** commonly called a lily, though not properly one, is an African flower. It was taken to England from the Cape of Good Hope in 1731.

The **Water-Lily** also is not a lily, but a plant belonging to the family *nymphæa*, so called because it was dedicated by the Greeks to the water nymphs. The Victoria regia, the largest of the water-lilies, with leaves 6 to 12 feet across, and flowers 12 to 16 inches, comes from the Amazon in South America. The blue water-lily, from Egypt, is a kind of LOTUS.

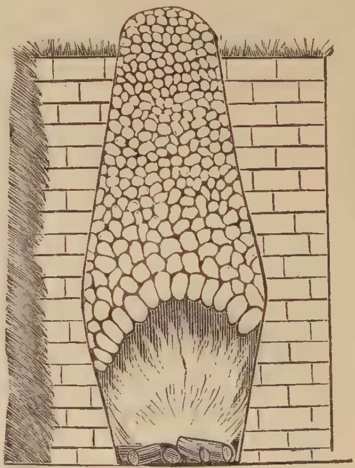
The **Fleur-de-lis** (flower of the lily), or fleur de Louis (flower of Louis), sometimes called lily of France, because it was chosen by Louis VII. for the symbol of the royal family, is an iris and not a lily.

The word lily is from the Latin *lilium*, lily.

LIME. See LEMON.

LIME, usually called quicklime, the oxide of CALCIUM. It is a hard, white substance, and cannot be melted: it is therefore much used in making crucibles for melting the hardest metals. When moistened with water it swells up, gives off much heat and steam, takes up HYDROGEN from the water, and changes into a soft white powder, commonly called slaked lime (calcium hydrate). So much heat is caused by the union of lime with water that buildings and ships have sometimes been set on fire by it. Slaked lime is much used for purifying coal GAS, for making mortar and plaster for ceilings, for removing the hair from skins in tanning, in making PAPER pulp, and as a manure for land.

Lime is made commonly by burning limestone (calcium carbonate) is furnaces called kilns. A lime-kiln is usually built against the side of a hill, as shown in the picture. An arch of limestone is first made



Lime Kiln.

across the inside, above where the fire is to be, and the rest of the limestone is then piled on it until the kiln is filled. Wood is generally used for fuel, and the fire is kept up three or four days, when all the CARBONIC ACID will have been driven off, and only the calcium oxide left. Lime is sometimes made also by burning marble, and oyster and other shells. Besides the uses already mentioned, lime is used in the making of caustic SODA and caustic POTASH, in the manufacture of bleaching powder and ammonia water, in refining SUGAR, as a flux (see IRON) in smelting metals, and for many other

things. Bleaching powder, commonly called chloride of lime, is made by passing CHLORINE gas into chambers filled with layers of powdered slaked lime. Chloride of lime is a dry white powder, with a slight acid smell. When left in the air it takes up carbonic acid and gives off chlorine, which destroys bad smells. It is therefore much used for purifying drains, sewers, and other bad-smelling places. But its chief use is for bleaching cotton and linen cloths, and great quantities of it are made every year for this purpose.

The word lime is from the Anglo-Saxon *lîm*, cement, glue.

LIMPET, a kind of MOLLUSK living in salt-water. The common or rock limpet has a shell cone-shaped above and flat below, and a large thick foot which acts as a sucker, by which it adheres firmly to rocks and to other shells. Experiments made with limpets prove that it is one of the strongest of animals. A limpet which weighed, without its shell, less than half an ounce, required a force of sixty-two pounds to tear it from a rock where it had fastened itself. Even bits of rock are sometimes broken off in trying to pull away a limpet.

LINDEN, a family of trees growing in Europe, Asia, and North America. These trees are also called lime trees; in the north of Europe bast trees; and in the United States basswood trees. The linden is a large, beautiful tree, with thick foliage, and makes a fine shade for streets and avenues. The principal street of Berlin is called *Unter den Linden* (Under the Lindens), from the lindens with which it is lined. The flowers of lindens are very sweet, and are much liked by bees. In Germany and in the Western United States great quantities of fine honey are made near the forests of these trees.

Linden wood is light and soft, but tough and lasting, and is much used by carvers and turners. The white wood carved toys and other wares brought from the Tyrol and South Germany are made of it. Wooden bowls and boxes, the seats of chairs, sounding boards for pianos, etc., are also made of it. Its charcoal is used for tooth-powder and for making crayons and gunpowder, and its inner bark is the bast of commerce, from which mats, coarse sacking, fishing-nets, ropes and cordage, and baskets, are made.

The word linden is from the Anglo-Saxon *lind*, linden.

LINEN, cloth woven out of flax threads. Linen stuffs were used by the ancient Egyptians and Hebrews. The bandages of mummies are of linen, and the flax plant from which linen was made is shown in pictures on the monuments. In the article FLAX is told how the fibres of the flax plant are made ready for spinning into thread. In old times thread was spun by women on spinning-wheels turned by hand, but now it is mostly made by machines. For the finest kinds of cambrics and for laces, however, the threads are still made by hand. Linen cloths, too, were once made by hand, but they are now woven almost wholly by machinery. The chief kinds of cloth made are lawn, CAMBRIC, DAMASK, diaper, sheeting, and towelling, The best linens are made in France, Belgium, Holland, and Great Britain. Most of the linen used in the United States is brought from Europe.

The word linen is from the Latin *linum*, flax.

LINSEED, the seed of FLAX. The seeds are rich in mucilage and in oil, and make excellent food for cattle and poultry; but they are used chiefly for making into oil and oil-cake. In making oil the seeds are first ground or crushed and then pressed either cold or heated by steam. The seeds give more oil when heated, but the cold-pressed oil is the best. The remains of the seeds, after the oil is pressed out,

make oil-cake, which is valuable for feeding cattle. Linseed oil is largely used in making paints, varnishes, and printing inks. It is generally boiled because paint mixed with it dries more quickly in the air than when mixed with raw oil.

The word linseed is from the Anglo-Saxon *lin*, flax, and *sæd*, seed.

LION. This animal, which is the largest of the cat family, is found only in Asia and in Africa. The Asiatic lion is not so large nor so fierce as the African lion, and has a smaller mane. The African lion is one of the strongest of beasts, and can drag away a good-sized ox or horse. It is generally six or seven feet long, and about three feet high at the shoulder. The male has a long thick mane, which gives his head a large and noble appearance, but the female has no mane. The tail has a tuft at the end, while that of the tiger and leopard is smooth. The lion is always of one color, that is, without spots or stripes, generally tawny, but the mane is darker, sometimes nearly black. It gets its full growth when seven or eight years old, and lives usually about twenty-five years, though some have lived much longer in menageries.

Lions live where game is plenty, usually in an open country where herds of animals feed, and near places where there are woods enough to protect them from the hot sun. They generally hide away in the daytime, and prowl around in the evening and early morning, and sometimes all night long, in search of food. This is because they see much better in the night than in the daytime. They feed chiefly on antelopes, zebras, giraffes, and wild cattle, but sometimes carry off horses, sheep, and other domestic animals, and when very hungry will attack men; but it is generally only old lions whose teeth are too poor to hunt who prowl around villages for food.

The lion is so savage and fierce in his wild state that many people think it a very wonderful sight to see a man go into his cage in a menagery; but the lion is easily tamed and can be trained with but little trouble. In ancient times lions were used in many ways. Hanno, the Carthaginian general, had one to carry his baggage, and Mark Antony often rode in the streets of Rome in a chariot drawn by lions. A story is told by one of the old writers of a slave named Androclus, who, while hiding away from his master in the desert in Africa, cured a lion of lameness by pulling a thorn out of its foot. He was afterward caught, carried to Rome, and condemned to be eaten by wild beasts. He was thrown into the den of a lion, but the beast, instead of tearing him to pieces, fawned upon him and showed the greatest delight at seeing him, and Androclus was astonished to find that it was the same lion whose wounded foot he had cured in Africa. The emperor was so much pleased at the sight that he pardoned him and gave him the lion, and Androclus used to walk the streets leading it around by a chain.

In modern times also many lions have shown friendship for men. In 1799, two lions in the *Jardin des Plantes* (Garden of Plants), Paris, became so fond of their keeper that when he was taken sick they showed the greatest sorrow, and when he got well and came back to them, they rushed to meet him and roared with joy while licking his hands and face. A lioness in London would let her keeper ride on her back, and even drag her about by the tail. Theodorus, King of Abyssinia, who killed himself in 1868 when the British took his city of Magdala, used to keep several tame lions in his palace, where they were treated much like dogs.

Lions sometimes show fondness, too, for other animals, especially when they are of use to them. An

old lioness in the Dublin Zoölogical Gardens was taken sick, and during her illness was much troubled by rats, which she was not able to drive away. A terrier dog being put into her cage, she, not knowing that he could aid her, received him with a surly growl; but when she saw him kill a rat, she coaxed the little dog to her, fondled him, and every night after that he slept beside her with her paws folded round him.

Lions were much more numerous in ancient times than they are now, and were plentiful even in the northern parts of Greece. The Romans caught a great many, and used them in the games and fights in their amphitheatres. It is said that Pompey and Cæsar used up a thousand in this way in a short time. But lions have been unknown in Europe for many hundreds of years, and they are scarce in most parts of Asia, being found only in Arabia, Persia, and India.

The lion is now much hunted in Africa, and there will soon be but few even there. Many hunters go there to shoot them, for the pleasure of it. The Arabs also kill many by digging a deep pit in the path where they have often seen a lion go. They cover the top over with a roof of branches and turf, and on this fix a bait, either a live lamb or a large piece of fresh meat. The lion springs on the bait as soon as it sees it, and falls into the pit. When one is caught in this way, the people of the village gather round the pit and worry it for a time and then shoot it. Sometimes, too, men lie in wait in trees and shoot the lion when it comes along.

The lion is generally called the "king of beasts," and most hunters and travellers speak of it as a very savage and terrible animal, but some say that it is to be feared only when very hungry, and that generally it is afraid of man. Dr. Livingstone says that when the lion meets a man in daylight, it will stop one or two seconds to stare at him; it will then turn slowly round, and walk off a few steps, looking over its shoulder; then it begins to trot, and lastly bounds off like a hare as soon as it thinks it is no longer seen. He says also that the roar of the lion is much like the cry of the ostrich, but the lion roars only by night while the ostrich cries only by day.

The lion is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the same family with the TIGER, LEOPARD, PANTHER, COUGUAR, LYNX, and common CAT.

The word lion is from the Latin *leo*, Greek *leon*, lion.

LIQUORICE. See LICORICE.

LITHOGRAPH, a picture printed from a drawing on stone. The stone used is a kind of limestone, found in Bavaria. It is made up chiefly of lime, clay, and silica (see SILICON), is usually of a pearl-gray color, and has a very fine grain. The stones are taken out of the quarry in large pieces and afterward sawn up into slabs two or three inches thick and of any size wanted. The face of the slab is then ground perfectly flat and polished smooth, when it is ready for the artist to draw on.

The drawing can be made either with a crayon or with pen and ink. The crayons used are made mostly of tallow, wax, hard soap, and SHELL-LAC, colored with lamp-black; and the ink is a little piece of crayon mixed with some water. The artist draws his picture on the stone just as he would on paper, sometimes using a crayon for broad lines, sometimes a pen for fine lines, and sometime putting in shades with a brush dipped in the ink. When the drawing is done it can easily be washed off with a wet sponge; but weak NITRIC ACID is poured over it, the acid unites with the ALKALI in the soap of the crayon, and the rest of the crayon cannot then be washed off. The acid also eats into the stone a little in all the parts not cov-

ered by the ink, and this leaves the lines of the drawing a little higher than the other parts.

After the drawing has become dry, it is ready to be printed from. The stone is fastened on the bed of the press, and then wet with a sponge. The water wets all the clean parts of the stone, but not the parts drawn upon with the greasy crayon. The drawing is then inked with the common printer's roller; the ink sticks to the greasy lines of the drawing, but not to the wet parts of the stone. A sheet of paper is now laid on the stone and the whole is passed under a heavy roller, which presses all the ink on to the paper, and thus prints the picture. The stone is then wet and inked again, and is ready for printing another picture.

Sometimes the picture, instead of being drawn on the stone, is made on thin paper called transfer paper, which is coated on one side with a mixture of gum, starch, and alum. The drawing is thus made on the coating and not on the paper itself. The paper is then laid on the stone face downward and pressed, and the ink of the drawing sticks fast to the stone; the back of the paper is next moistened with water, which loosens the gum, and the paper may then be taken off, leaving the drawing sticking to the stone. The rest of the gum is now washed off the ink, and the stone can be printed from, just as if the drawing had been made on the stone. Copperplate maps are now mostly printed in this way, instead of from the plates themselves. A print is made from the copperplate on transfer paper, and then transferred to a stone. Maps printed in this way are just as good as those printed from the copperplate, and the copperplate, which costs much money to engrave, is saved from wearing, and many more maps can thus be made from it.

Chromo-Lithographs are lithographs in which many colors are printed in one picture. Each color is printed from a separate stone, so that in printing a picture of many colors, twenty or thirty different stones are used. As each stone is made to fit its own part of the picture, the drawing has to be made with the greatest care, for if one color should be printed the least bit out of its place on the paper the picture would be spoiled; but one stone is often printed over the color made by other stones, so as to make various tints or shades of color.

Oil paintings are often copied in this way so well that the copies might easily be mistaken for the paintings themselves by those who do not know oil paintings well. Maps are also colored in the same way, each color being printed separately; but electrotype (see METAL WORK) plates are now mostly used instead of stones. Generally only three plates are used, one for blue, one for yellow, and one for red. Green can be made by printing yellow over blue, orange by printing yellow over red, and purple by printing red over blue; thus six colors, can be printed from the three plates.

Photo-Lithographs are pictures printed from stones, on which the drawings have been made by the action of light, that is, by photography. There are many ways of doing this, but usually a photograph is taken on prepared paper and the picture transferred to the stone in much the same way as a drawing, when the stone may be printed from in the usual way. Engravings, maps, drawings, etc., may easily be copied thus.

The word lithograph is from the Greek *lithos*, stone, and *graphein*, to write.

Chromo-lithograph is made up of the Greek *chromos*, color, and lithograph.

Photo-lithograph is made up of the Greek *phos*, light, and lithograph.

LITMUS, a blue coloring matter

got from the archil or orchella weed, a kind of LICHEN. Several kinds of archil grow on the rocks of the coast of the Mediterranean and in other warm countries. Litmus is prepared by pounding up and soaking the lichens several weeks in water, to which urine, lime, and potash or soda are added. After it ferments (see YEAST), it becomes at first reddish and then blue, when it is mixed with clay or plaster and made into little cakes. It looks somewhat like indigo, and has a smell like violets. Paper dyed with litmus will turn red when put into ACID; and will then turn blue again when put into an ALKALI. It is therefore used by chemists and others as a test for acids and alkalies. Litmus paper is made chiefly in Holland.

Litmus is a corrupt form of lacmus, from the Swedish *lakmus*, from *lak*, lac, or the dye got from lac, and *moes*, pulp.

LIZARD. These REPTILES are found in almost all countries, but are most plentiful in warm climates. Most of them are shaped much like crocodiles, and have four feet, but some have only two, and others have the feet so short and so covered up with skin that they look more like snakes. They vary in length from a few inches to several feet; are of different colors, such as black, blue, green, yellow, red, brown, gray, or white; and their skins are covered with small scales. They have small heads and thick necks, and some of them have long tongues, which they can dart out very quickly to catch insects. Some lizards live mostly in the water, some wholly on land, and some on trees. Land lizards are generally nearly of the color of the soil, tree lizards are bright colored, mostly green, and those which live among rocks are gray. Their food is chiefly insects, worms, eggs, small birds and mammals, and reptiles. They drink by lapping like dogs and cats. Most of them lay eggs. Lizards' tails are almost as brittle as glass, and will snap off at the lightest touch. A glove or handkerchief thrown upon one is enough to break it off, and it will lie wriggling while the animal runs away; but a new tail will soon grow out. If the tail be cracked a little, instead of being broken off, a new tail will grow out of the crack, so that it sometimes happens that a lizard has a forked tail.

The **Iguanas** of Central and South America are among the principal kinds of lizards. They are very large with a tufted crest on the back, and a thick short tongue. The flesh of one kind is white, and is much liked for food in the countries where it lives. It grows nearly as long as a man, and spends its time mostly in trees, where it is caught with slipnooses.

The **Monitors** of Asia and Africa, some of which are longer than a man, are so called because they always make a kind of whistling or hissing sound when a crocodile is coming, thus giving warning to all who are near. They eat many of the eggs and the young of crocodiles.

The **Frilled Lizard** of Australia has on each side of the neck a wide fold of skin much like the ruff worn in Queen Elizabeth's time. Another Australian lizard has its body covered with pointed spikes.

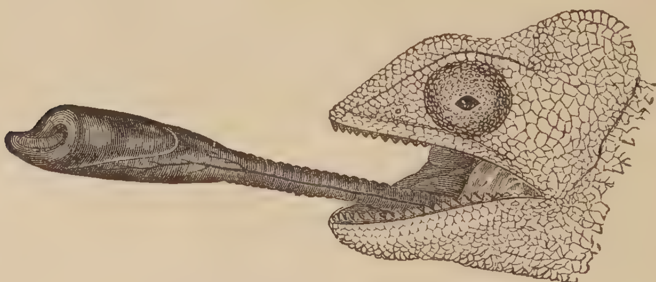
The **Gecko** of India has suckers on the ends of its fingers and toes, so that it can walk up walls and along ceilings like flies.

The **Chameleons** are the most singular of the lizards. They live chiefly in Africa, India, and other warm parts of the Old World, but are not found in the New World. They are ugly looking little animals, with a flat body and a sharp-ridged back. They move very slowly, taking hold of the branches of trees with their claws, and using their tails as monkeys do, to hold on to things with. It has been commonly said that the chameleon lives on air

and changes its color to the color of the things around it; but the first story is not true, and the second one only partly true. People thought it lived on air because it has a way of blowing itself up full of air, so that it looks very fat, and it moves its tongue so quickly in catching insects that it can scarcely be seen. This tongue is a long hollow tube with a thick fleshy end, which is always covered with a sticky substance. The picture shows the head, with the tongue run out to catch an insect. The color of the chameleon's skin changes often, but the change is made by the swelling and shrinking of the skin and has nothing to do with the color of things on which the animal happens to be.

The word lizard is from the Latin *lacerta*, lizard.

LLAMA, an animal somewhat like the camel, found only in South America. It is smaller than the camel, is more slender and graceful, and has no hump on the back, though it has a thick bed of fat under the skin. Its feet, too, differ from those of the camel, having two toes with strong nails fitted for climbing mountains instead of traveling over sandy deserts. The llama lives in flocks among the Andes, especially in the coldest parts, where snow lies all the year round, and feeds mostly on coarse grasses, MOSSES, LICHENS, and shrubs. When it has juicy food it does not need to drink water. It is very wild and shy, and keeps away from men. The young are sometimes caught with dogs and the lasso (see HORSE), but the old ones have to be shot. The flesh and milk of the llama are eaten, the dung is used for fuel, the skin for making leather, and the hair for spinning and making into several kinds of cloth. The ancient Peruvians tamed the llama and kept great numbers of them for beasts of burden, and it is still put to this use by the Indians of Peru and Chili, especially for carrying goods across steep mountain roads where horses cannot go. The wild llama is called guanaco. The ALPACA is a small kind of llama, much valued for its silky hair.



Head of Chameleon, with Tongue out.

The llama is a MAMMAL of the order *ruminantia*, or cud-chewing animals, and of the camel family.

The word llama is Peruvian.

LOADSTONE. See MAGNET.

LOBSTER. There is but one kind of lobster in the United States, and it is different from that caught in Europe. It is found all along the Atlantic coast north of New York, from spring until autumn, when it goes off into deep water to pass the winter. Lobsters differ in size, weighing usually from two to fifteen pounds. They shed their shell every year, a new one growing out in place of the old one. While this is going on they hide away among the rocks to escape fishes that prey upon them. They often lose their large

claws, and sometimes will cast one off when caught, but they soon grow out again. Their two large claws are fitted with teeth, but in one they are many and sharp and in the other few and blunt. With these they crush their food, which is chiefly clams, mussels, and other mollusks. Though the lobster has legs by which it crawls on the bottom, it moves

Freshly Hatched Lobster (Magnified).

chiefly in the water by means of its tail. By suddenly flapping this underneath its body, it is enabled to spring backward three or four times the length of a man with great swiftness. Its eyesight is very sharp, and when it sees danger coming it will dart into its hole as quickly as a mouse.

Lobsters lay eggs, but they remain hung in clusters, glued together with a kind of gum, to the hairy feet under the body of the mother, until they are hatched out. The young, which are nearly like the large ones, follow their mother round, hiding under her tail when they are frightened by anything.

Lobsters are caught in long round traps called pots, which have a netting with a hole at each end, and are so made that the animal can go in, but cannot get out again. They are baited with dead fish or meat, and sunk in deep water, their place being marked by a wooden float fastened by a rope to the pot. The pots are usually drawn up every day, the lobsters taken out, and then set again to catch more. A small wooden plug is driven into the joint of the large claw of each lobster to keep it from biting, and all are then put into floating boxes called cars, until wanted for market.

The shell of the lobster is dark green when the animal is alive, but it turns bright red when boiled. A French artist, who did not know this, once painted a lobster with a red shell swimming in the water.

The lobster is a CRUSTACEAN of the order *decapoda*, or ten-footed animals.

The word lobster is from the Anglo-Saxon *loppestre*, or *lopustre*, which is probably from the Latin *locusta*, the old Roman name of the lobster.

LOCK, a fastening for doors, drawers, boxes, etc., made to be opened and shut with a key. The chief parts of a lock are the bolt, or part that locks, and the staple, or part into which the bolt locks when turned by the key. The most common kind of locks are made with little round ridges of iron fastened to the back, as shown in the picture, Fig. 1, at B B. There is sometimes a pin in the middle of these

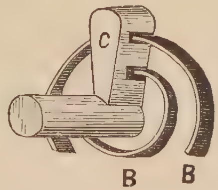


Fig. 1.—Wards of Lock.

ridges for a hole in the end of the key, C, to fit on, and the key itself has some notches filed in it, so made that the ridges will pass through them when it is turned round. If it were not for these ridges and notches, which are called wards, any key of the same size would open the lock; but a key which has no wards in it cannot get into the keyhole, because it will strike against the top of the ridges instead

of fitting over them as the true key does.

The **Spring Lock**, shown in the second picture, Fig. 2, was used everywhere before this century, and is still in common use in houses. In this A is the bolt, B B the iron ridges on the back, on which the wards of the key fit, and C is the key. The bolt has a slit, *a*, cut through the top of its back part, and the thin piece thus made is hardened into STEEL, so that it acts like a spring. Below are two notches, *b b*, with a round part, *c*, between them, and at *d* is a rounded hollow. When the key is put into the lock the wards are downward. It is then turned round until the end comes into the hollow *d*, as in the picture, Fig. 2, when the bolt is half locked. If it be turned a little more to the left, the bolt will move further along, and the right-hand notch *b* will fall into the edge of the rim of the lock and be held there by the spring *a*, which will press it down. The lock will then be fully locked.

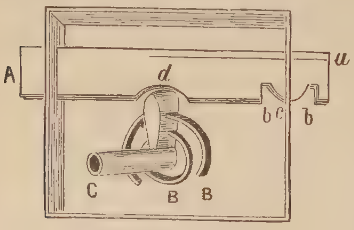


Fig. 2.—Spring Lock.

But if the key be turned a little to the right, instead of to the left, the bolt will move to the right until the left-hand notch *b* falls into the edge. The lock will then be unlocked.

The **Tumbler Lock** is another kind, the most simple form of which is shown in the third picture, Fig. 3. In this it will be seen that the bolt A has no spring on its top and no notches on the lower side excepting the rounded hollow in which the key turns. But it has two notches, *f f*, on the upper side, which are just as far apart as the bolt moves in locking and unlocking. Behind the bolt, between it and the back part of the lock, is a thin plate, B, called a tumbler, the covered parts of which are shown by the dotted line. This

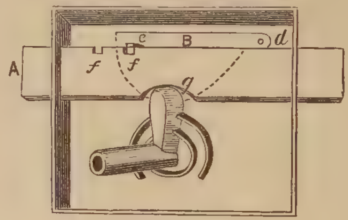


Fig. 3.—Tumbler Lock.

moves up and down on the little pin *d*, and has fastened to its other end a square pin, *e*, which falls into one or the other of the notches *f f*, as the lock is locked or unlocked. At the back end of the key is cut a little notch, *g*, which raises the tumbler when the key is turned so as to lift the pin *e*, out of the notch in the bolt, and let it be moved along until the other notch comes under the pin, when the pin falls into it, and the bolt cannot then be moved until the key is turned backward again.

The tumbler lock shown in the picture is the most simple kind, some locks being made with many tumblers, and some with several sets of tumblers, one set of which is moved by the other. Some locks also are made so that the tumblers work differently each time the key is turned, and others have keys in which the wards may be changed each time they are used, the parts of the lock always fitting the key. But when a lock is locked with one of these changeable keys, it can be unlocked only with the key set in the same way in which it was locked. Such locks are put on to safes, bank vaults, and other places where valuable things are kept.

The **Combination Lock** is so called because it is locked and unlocked by

means of different combinations of letters or figures—that is, letters or figures put together so as to make different words and numbers. These locks have no keys, but are locked by turning round a handle on the door, which moves a brass plate marked on the edge with the letters or figures. Suppose that the lock is a letter lock of four combinations, and that the word chosen is CATS. The door is closed, and the handle is then moved round until the letter C on the plate comes opposite a notch on the top. It is then turned again until the letter A comes under the notch, and so on with the other letters. The door will then be locked, and it can be unlocked only by spelling the same word, which, of course, must be done backward. If the lock has figures instead of letters on the plate, a number instead of a word would be chosen, but it would be locked and unlocked on the same principal. The plot of a celebrated French novel turns on the unlocking of a safe through the discovery that the word by which it was locked was the name of the hero's ladylove.

The **Time Lock,** much used on bank vaults, goes by clock-work, and can be opened only at a certain time. When the banker closes the door, he winds up the clock and sets it at the hour of the next day when he wishes it to open. If this be nine o'clock, for instance, when the pointer reaches that hour the clock-work turns and opens the lock. No one, not even the one who locks it, can open the lock before the time at which it is set. A story is told of some burglars who took the cashier of a bank out of his bed at night, carried him to the bank, and told him to unlock the vault for them. The cashier told them that he could not do so, because the safe had a time lock on it. One of the burglars said: "That won't do. There was no time lock on it last Saturday." "No," replied the cashier, "it was put on only last Tuesday." "Then we have lost our chance," said the burglar sorrowfully, "and we have been working for it for two months."

The word lock is from the Anglo-Saxon *loc*, a place shut in.

LOCOMOTIVE. The first carriage to be driven by a steam engine is supposed to have been built in 1769 by a French army officer, Nicolas Joseph Cugnot. It was intended to run on common roads and especially to drag cannon into the field for military purposes. It succeeded so well that he built another one the next year, and this second one, shown in Fig. 1, is still preserved in one of the museums of

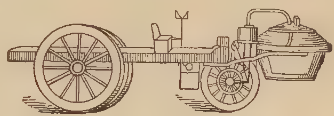


Fig. 1.—Cugnot's Road Locomotive.

Paris. After him many others, including Oliver Evans, an American, William Symington, William Murdock, and Richard Trevithick, tried to build locomotive engines, some to run on common roads and some on tramways, but none succeeded very well. It was then thought that iron wheels would not adhere sufficiently to rails to permit heavy loads to be drawn, so some built locomotives with toothed driving-wheels to work upon a rack-rail, and one man, named Brunton, actually constructed a locomotive to go on legs, like a horse. At length it was found out that the weight of the engine was enough to make the wheels draw without slipping, and Mr. Blackett, a colliery owner, had an engine (Fig. 2) built to draw coal wagons upon his tramroad at Wylam. This was in 1825, and the locomotive is said to have been able to draw fourteen loaded wagons four or five miles an hour.

In the meantime George Stephenson had been studying the problem. He had made in 1814 his first loco-

motive, which ran about four miles an hour. He then invented the steam-blast, by which the waste steam was carried into the chimney, increasing the draft and the speed. In 1815 he built another locomotive, which was a great improvement on his first one and contained the germ of all that has since been effected. Stephenson then built others, all for use in hauling coal from the mines, no one having thought of building one for the conveyance of passengers; but in 1825 the Stockton and Darlington Railway line was opened and Stephenson's engine drew a long train at the rate of twelve miles an hour. The road was built, however, for horses, and the locomotive was not adopted for drawing regular trains until the opening of the Liverpool and Manchester Railway in 1830. A trial of locomotives had been held at Rainhill, the year before, to decide on the best one. Four had been entered: the Novelty, by John Ericsson, the builder in 1862 of the Monitor; the Sanspareil, by Timothy Hackworth; the Rocket, by Stephenson; and the Perseverance, by Burstall. The Novelty came near winning, but on the second day it broke down, and Stephenson's Rocket, which ran twenty-five to thirty-five miles an hour, was given the prize of five hundred pounds and chosen by the railway company. The Rocket (Fig. 3), which thus proved the possibility of the modern railway, is now preserved in the South Kensington Museum, London.

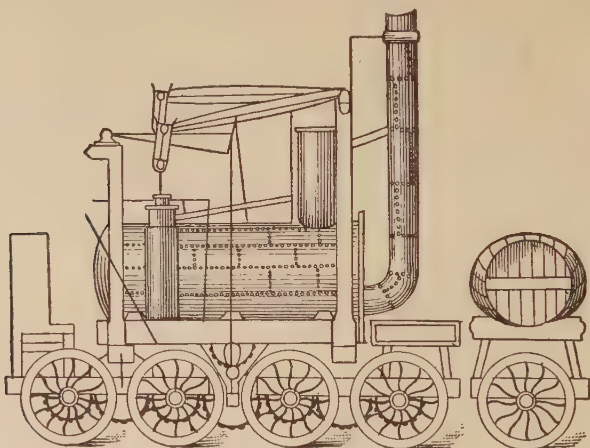


Fig. 2.—The Wylam Locomotive.

The Rocket weighed only four and a half tons, or nine thousand pounds; but locomotives soon began to be made heavier, and they are now built of nearly a hundred tons weight. Four locomotives for drawing heavy trains through the St. Clair TUNNEL weigh each one hundred and ninety-five thousand pounds, or ninety-seven and a half tons, equal to twenty Rockets.

The first locomotive in America was built by George Stephenson, and sent over in 1829 for the Delaware and Hudson Canal Company, to be used in hauling coal from their mines. In 1830 Peter Cooper built at Baltimore the first locomotive made in the United States, for the Baltimore and Ohio Railroad Com-

pany. American locomotives differ from English locomotives, both in looks and in other ways. Made to run on rougher roads and on curves, they have the forward end supported on trucks, or bogies as they are called in England (see RAILROAD, Fig. 7), which make them more flexible. They are provided also with a cow-catcher, which is unnecessary in Europe, where all railroads are fenced in. The cab, or house to shelter the engine-driver and fireman, seen on all American locomotives, was not used for a long time in England, though most engines are now fitted with it.

The machinery of the locomotive cannot well be described without many illustrations; but it is made up of a boiler with a fire-box at one end, the gases and heat from which are carried through the boiler in metal tubes, which lead into the smoke-stack or chimney. These tubes give off a great deal of heat and turn the water into steam very quickly. On each side of the boiler, at its front end, is a cylinder or iron barrel in which a piston (see STEAM-ENGINE), works, being pushed in and out by the action of the steam. These pistons and the parts connected with them turn the driving wheels and make the locomotive go. Locomotive engines are what are called high-pressure engines, that is, they do not turn the steam back to water and use it over again, as in the low-pressure STEAM-ENGINE, but let it escape into the air after it is used. In the eastern part of the United States anthracite COAL is mostly burned now in locomotives, but in some places bituminous coal is burned, and in others wood,

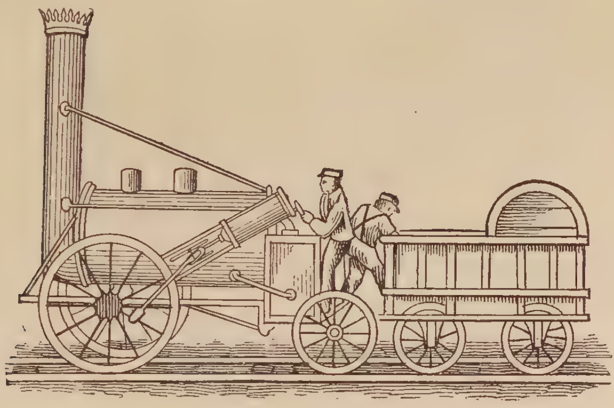


Fig. 3.—The Rocket.

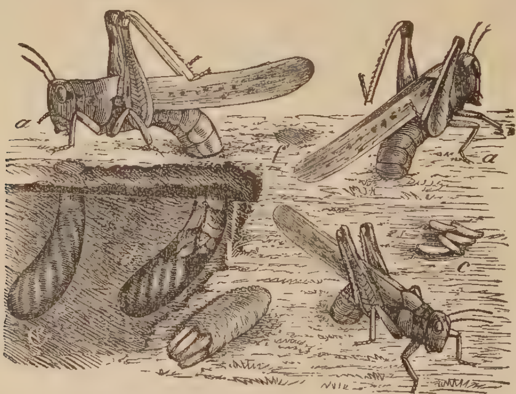
The word locomotive is from the Latin *locus*, a place, *motivus*, moving, and means moving from place to place.

LOCUST. This insect is something like a grasshopper, but has shorter antennæ or feelers and stouter legs, having only three foot joints, while the grasshopper has four. Its hind legs are especially strong, enabling it to make great leaps, and its long wings give it the power of flying great distances. The males make a kind of scraping noise by rubbing their legs against the edges of their wing covers. The females dig holes in the ground and lay their eggs in them in the autumn, in little masses cemented together. The young locusts are hatched out in the spring, and like

the young of grasshoppers, are wingless.

Locusts live on the leaves and green stalks of plants, but after these are gone they will eat the bark of shrubs and trees. In Asia and in Africa they come in such numbers as to darken the air in their flight, and strip the earth of every green thing, eating the leaves and bark from the trees, and the grass down to the roots. They will also eat anything made of silk, wool, linen, or leather. They are frequently seen in Southern Europe and sometimes commit great ravages there. The Arabs, who dread the locust, say that it has stolen a part from every bird and beast: taking its body from the scorpion, tail from the dragon, legs from the stork, wings from the eagle, head from the horse, eye from the elephant, neck from the bull, and breast from the lion.

Locusts are eaten in countries where they are plentiful; they are boiled, fried in oil or butter, or dried, ground into flour, and made into bread. Dried locusts are sold in the markets of Arabia, Syria, Egypt, and other Eastern countries. In South Africa all kinds of birds and animals, even lions and elephants, feed on them, and horses, cows, and sheep fatten on them.



Rocky Mountain Locust.

Locusts are also very destructive in the Western United States, where they are commonly called grasshoppers. They appear sometimes in immense numbers between the Mississippi River and the Rocky Mountains, settling down on the fields, and stripping them of their crops.

The locust belongs to the order *orthoptera*, or straight-winged INSECTS.

The word locust is from the Latin *locusta*, locust.

LOCUST, a kind of tree which grew first in North America, but is now raised also in different parts of Europe. It grows very large in the southwestern parts of the United States, and is much planted in places where trees are scarce. Its leaves are soft and velvety, and it bears clusters of white, sweet-smelling flowers. Its wood, which is yellow, is very valuable, and is used for railroad-ties, fence-posts, and in building certain parts of ships.

The **Honey Locust,** found mostly in the Southern and Southwestern States and in parts of the Middle States, is also a large tree, but is not so valuable as the common locust, its wood being good for little but firewood. It bears small flowers, and long flat pods, full of brown seeds

in a honeylike pulp. Its trunk and large limbs have on them long sharp thorns in branches.

The locust tree is so called because its branches look something like the legs of a flying locust.

LOG, an apparatus for measuring the speed of a ship. It consists of the log-chip, a piece of board shaped like the fourth part of a circle, loaded with lead on the round side, so that it will stand up in the water, and the log-line, a line 150 to 200 fathoms long, which is wound up on a large reel, so held as to let it run out easily. The line is divided into equal parts by bits of string run through it, each marked by the number of knots in it, whence these divisions are called knots. When the log-chip is thrown overboard it stands still in the water and draws out the log-line as fast as it unwinds, and the speed of the ship is shown by the number of knots that run out in half a minute. As the usual length of a knot is 47.3 feet, it is easy to calculate, when it is known how many run out in half a minute, how many would run out in an hour. So the vessel is said to be going so many knots or nautical MILES an hour. The record of the heaving of the log, as well as all the other important things happening on shipboard, is made in a logbook.

LOGWOOD, a dyewood obtained from the logwood tree, which grows in Central America, Mexico, and some of the West India islands. The tree, which is five or six times as tall as a man, is crooked and covered with thorns. The sapwood, or wood next to the bark, is yellow, but the heart wood is deep red. Only the red part is used. It is sent in short logs to foreign countries, where it is cut up into small chips and boiled in water to get out the dye. Logwood may be used, according as other things are mixed with it, for dyeing bright and dark red, lilac, violet, purple, and black.

Logwood is so called because it is sent to other countries in logs.

LOOM, a machine on which a weaver makes cloth out of thread. It is one of the oldest machines known to man. The looms of the ancients were much more simple than those now used, but the finest kinds of cloth were woven on them. Those of the Hindus and Chinese are similar to those used in ancient Egypt, pictures of which are still to

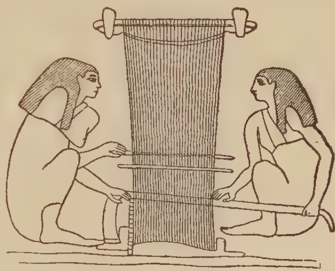


Fig. 1.—Egyptian Loom.

be seen on the monuments. The picture (Fig. 1), showing Egyptian women weaving on a loom, is taken from a painting on a tomb at Beni-Hassan.

To understand how threads are woven together on a loom the article CLOTH should be read first. The common hand loom is shown in Fig. 2. In this A A A A is a heavy frame which holds the parts of the loom together. At each end is a roller, B, called the yarn beam, and C, the cloth beam. The threads of the warp are wound round the yarn beam, and kept tight by the weights W W; only enough of each thread is left unrolled to reach to the cloth beam. But before they are carried to the cloth beam the warp threads are separated into two equal sets, each of which is passed through the loops of one of the healds.

The healds are two sets of strings, D and E, each of which is connected at top and bottom by rods. They are so hung by cords over pulleys, and fastened at the bottom to the two treadles, F G, that when one is

pushed up the other comes down. In the middle of each one of the heald strings is a little loop, through which the warp threads are passed, one set of them being put through the loops of one heald and the other set through those of the other, so that when one heald goes up and the other down, the warp threads are divided into two parts so as to leave an open space between them. This space is called the shed. After being put through the loops of the heald threads, the warp threads are next

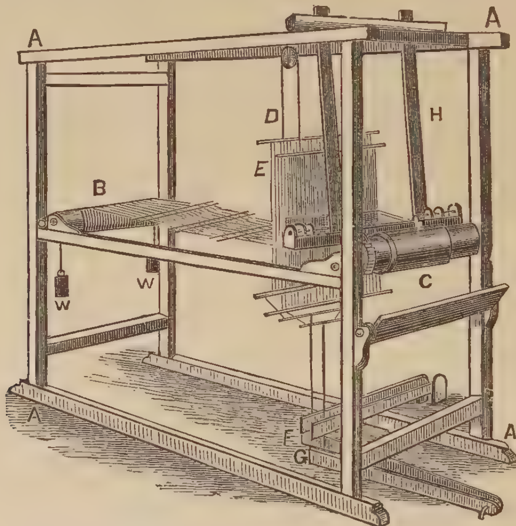


Fig. 2.—Hand Cloth-Loom.

passed through the teeth of a reed hung to a frame H, called the batten, which is made to swing backward and forward from the top of the loom frame. The reed is a narrow frame set with wires which are just far enough apart to let a thread of the warp pass between each. The warp threads are next fastened to the cloth beam, on which the cloth is wound up as fast as it is made.

The weft thread, which is to be woven in with the warp to make

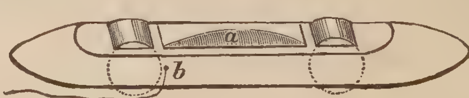


Fig. 3—Shuttle.

cloth, is contained in a little instrument called a shuttle. The shuttle, which is shaped something like a boat, as will be seen in Fig. 3, is usually about a foot long. In the middle is a little hollow or box, containing the BOBBIN, *a*, around which the weft thread is wound. The bobbin turns round on a wire so easily that the least strain will unwind the thread, which is drawn out of the little hole *b*.

In making cloth the weaver takes his seat at the cloth beam end of

the loom. By pressing his foot on the treadle G, the heald E is drawn down and the heald D up at the same time. This lifts the half of the warp threads which go through the loops of D and draws down the half through those of E, opening the shed. The weaver now throws his shuttle through the shed, and the weft thread, the end of which had first been fastened, unrolls from the bobbin and is passed through the warp. The batten is now swung up so as to drive the reed hard against the weft thread, and make it even and tight. The weaver next presses his other foot on the treadle F, which draws the heald D down and the heald E up. This crosses the threads of the two sets of warps, so as to shut in the weft thread, and opens a new shed. The shuttle is now thrown back the other way, by which another weft thread is put in. This is driven up by the reed close to the first, and the weaver goes on in this way, putting in one weft thread after another until his cloth is done.

In some looms there are many more than two healds, and in steam looms there are other parts which affect the work, but the principle is always the same as in the hand loom.

The word loom is from the Anglo-Saxon *geloma*, a tool or implement, meaning a thing in frequent use.

LOON, a large heavy bird with a long neck, abundant on northern sea coasts and inland waters. It is sometimes called the great northern diver. The common loon has a glossy greenish-black head and neck, a glossy black back, and white under parts, with black feet. It is 30 to 36 inches long. The loon is noted for its power of diving, and will escape the shot from a gun by disappearing at the flash, and swimming under water to come up again a long distance away. Its voice is loud and harsh and can be heard far off. It breeds in the far north, laying two or three greenish-drab spotted eggs in a rude nest by the water's edge. In winter it goes southward.

The loon belongs to the order *natatores*, or swimming BIRDS.

The word loon is corrupted from loom, which is in Icelandic *lomr*.

LOTUS, a name given to several different plants famous in mythology. The lotus tree, whose fruit was the food of the Lotophagi, or lotus-eaters, a people who lived on the north coast of Africa, told about by Homer in the Odyssey, and celebrated by Tennyson in his "Lotus-Eaters," is supposed to be a kind of prickly shrub, growing in Northern Africa and Southern Europe. It is a species of JUJUBE, and bears a sweet, pleasant-flavored fruit, about as large as an olive. It is not so good as the common jujube, but is much eaten where

Egyptian Lotus.

it grows, and is made into a kind of wine. The companions of Ulysses who ate of it are said to have become listless and forgetful of their friends, and unwilling to return to their own country. Hence, anyone who leads a dreamy kind of life, given up to pleasure, is commonly called a lotus-eater.

The lotus of Egypt is a water-LILY. There are several kinds, the white lotus and the blue lotus, which still grow in the Nile, and the red lotus, the true Egyptian lotus, so often described by ancient writers and figured on the monuments, which is not now to be found growing wild either in Egypt or any other part of

Africa. It grows, however, in India. It is a third larger than our common water-lily, and its leaves, instead of lying on the water, rise up 12 to 15 inches above it, with the flower still higher. It has a scent like anise, and in ancient pictures people are shown smelling it. The fruit contains seeds as large as an olive stone, which were eaten green, and dried in such quantities in the Nile valley that the Latin and Greek writers called them Egyptian beans. The lotus is also a favorite subject in Indian and Chinese art.

The word lotus is Latin, from Greek *lotos*.

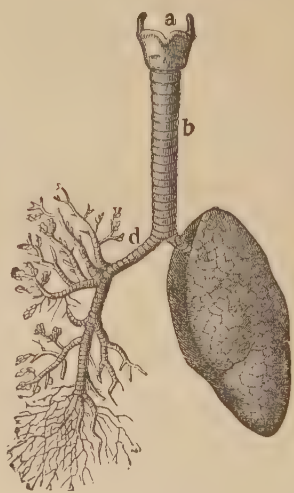
LOUSE. There are many kinds of lice, some of which live on the body of man, aud others on different birds and quadrupeds. The common head louse, which sometimes gets into children's hair and causes a great itching, is a small grayish-white insect. Each female lays about fifty little bean-shaped eggs, which are stuck to the hair by a kind of glue, and are usually called nits. After six days the nits hatch and after eighteen days more the young are full grown. The louse has a very sharp beak which it thrusts into the skin, and then sucks blood through a little tube which acts something like a pump. Fowls, dogs, cats, goats, and other animals all have different kinds of lice which live on them.

The louse belongs to the order *hemiptera*, or half-winged INSECTS.

The word louse is from the Anglo-Saxon *lus*, louse.

LUNGS. In man the lungs lie in the chest, on each side of the heart, filling up nearly all the space which is not taken up by the heart. They are light, spongy bodies, full of little cells or holes which can be filled with air. Imagine a thick short bush with many branches crowded with leaves, turned bottom upward; imagine the trunk, the branches, and the twigs all hollow, and the leaves themselves to be little cells like hollow bladders, so that when you blow down the trunk, all the branches, twigs, and leaves will swell out, and when you stop blowing they will all shrink up again. Around this framework of hollow branches are wrapped arteries, veins, and capillaries, in such a way that each air cell or hollow bladder is covered closely with a fine network of capillaries, through which the BLOOD passes.

The following picture of the lungs shows on one side the framework of the right lung, with the arteries, veins, and capillaries cut away, and on the other the framework of the



Lungs of Man.

left lung covered with its arteries, veins, and capillaries, just as it is in the body. When we breathe the air passes down through the wind-pipe *b*. This has two branches, *d* and *c*, through which the air goes to each lung, and passes through all the branches into the air-cells, around which the blood capillaries are wrapped. The skin of the air-cells is so very thin that the blood in

the capillaries is separated from the air in the cells by a sheet so thin that gases can easily pass through it. The air which we breathe passes through the nose and mouth down the wind-pipe into the tubes of the lungs. On one side of these tubes is the air breathed in, and on the other is the blood. The OXYGEN from the air passes through this thin skin into the blood and unites with its CARBON, burning it up and forming CARBONIC ACID; which then passes through the thin skin into the lungs and is breathed out into the air. The blood with which the oxygen unites is the dark purple BLOOD which comes from the lung artery. By taking in oxygen from the air and at the same time giving off carbonic acid this dark venous blood is turned into bright scarlet blood, which passes by the lung veins into the heart, to be again forced through the body to give food to all its parts.

With every breath air goes in and out of the lungs, but it is only a small quantity, for the lungs are not filled and emptied at each breath. The air breathed in goes only into the large branches of the wind-pipe, and does not go into the air cells at all. But they are all the time filled with air, which takes up the oxygen from the outer air and gives off carbonic acid to it. The air breathed in is made up of twenty-one parts of oxygen and seventy-nine parts of NITROGEN, but that breathed out has in it only sixteen parts of oxygen, with five parts of carbonic acid, and seventy-nine parts of nitrogen. So it will be seen that the nitrogen does not change at all; just as much of that is breathed out as was breathed in; but five parts of the oxygen have been exchanged for as many parts of carbonic acid. The oxygen has gone into the blood, and the carbonic acid has come out of the blood; thus the air breathed into the lungs gives the blood the oxygen which it needs and takes from it the carbon which it does not need, changing the impure venous blood into pure arterial blood.

No being can live and be healthy without pure air, that is, air with plenty of oxygen in it, because it is needed all the time to keep the blood pure. If we are cut off from the air a little while, we die, because the blood gets so clogged up that it cannot do its work rightly. Babies have sometimes been smothered by mothers or nurses who did not know, or did not think of this. A mother who had to go on a long sleigh-ride once in very cold weather, wrapped her baby up so closely in shawls and furs that it could not get any fresh air to breath; and when it was unrolled at the end of the journey the poor little thing was found to be dead. Boys ought to be very careful how they heap hay upon each other in play, as a child has been known to be smothered in this way. It is very dangerous, too, to shut a child up in a trunk or chest, as is sometimes done in play. There was once a beautiful Italian lady named Ginevra, who, on her bridal day, playfully hid away from her husband in an oak chest in a garret. The lid closed with a spring lock, and as no one knew where she was, she soon smothered to death. She was looked for everywhere, but she could not be found. At last, more than fifty years afterward, when the chest was opened a skeleton was found in it, and on it were the jewels she had worn that night. Her sad story is told in verse by the poet Rogers.

But the most dreadful story of death from want of air is that of the Black Hole of Calcutta, in which one hundred and twenty-three British prisoners were suffocated. The Black Hole is a small dungeon in Fort William, Calcutta. In 1756 Surajah Dowlah, the Indian ruler of Bengal, took the city, and put its garrison of one hundred and forty-six men into this dungeon, which had only two small windows on one side, covered with iron bars. The

prisoners suffered terribly during the night, for there was not air enough for them to breathe, and in the morning only twenty-three of them were found alive. They could not get oxygen enough, and as their lungs were all the time giving out carbonic acid, the air in the dungeon was soon loaded with that poisonous gas.

Every person needs about three hundred and fifty cubic feet of air every twenty-four hours. This would fill more than two thousand two hundred and fifty gallon measures. Out of this air he takes into his blood, through his lungs, an amount of oxygen equal to more than four times the size of his own body, and breathes out nearly as much carbonic acid. So the air which we breathe must not only be plentiful, it must also be of the right kind. It must have in it enough oxygen, or men cannot live; and it must be freed from the carbonic acid which men themselves breathe out, or it will kill them. From this we see how necessary it is that all rooms should be well ventilated.

The word lung is from the Anglo-Saxon *lunge*, plural *lungen*, lung.

LYNX. The animal commonly called the wild-cat in the United States is really the bay lynx, so called on account of the color of its fur, which is bay or reddish-brown in winter and ashy-brown in summer. It looks much like a very large cat, but has a shorter tail than the common cat. It lives on smaller animals, such as hares and rabbits, but sometimes prowls around farms and carries off young pigs and poultry. Lynxes are frequently caught in traps in the Middle States and in New England, and in the winter time their cries are often heard in the woods. It is a cowardly animal and will not attack a man unless closely pressed or cornered, when it will scratch terribly.

The **Canada Lynx** is a little larger than the wild-cat, being about the size of a setter dog, and is gray above and light gray below. It lives in the deep woods of Canada, and seldom comes into the United States. The Indians hunt it for its fur, which is prized for robes, muffs, and collars.

The lynx is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the cat family, which includes also the LION, TIGER, JAGUAR, COUGUAR, PANTHER, and common CAT.

The word lynx is Latin, Greek *lugx*, lynx, probably so called from its bright eyes, from *lux*, light.

LYRE, a stringed instrument of the harp family. Its origin is unknown, though it is thought to have been Egyptian. It was early introduced into Greece, where it became the national instrument, and sacred to Apollo, the god of music and poetry, though Mercury was said to have made the first one by stretching strings across a tortoise-shell. The lyre, which had generally seven strings, but sometimes even eighteen or twenty, was held between the knees and played with a plectrum or lyre-stick of ivory or hard wood, held in the right hand, and by the fingers of the left hand. It was used for accompanying singing and recitation, from which comes our word lyric, lyric poetry among the ancients meaning poetry sung to the lyre.

The word lyric is in Latin *lyra*, from Greek *lura*, lyre.

M

MACARONI, a kind of food made of a paste or dough of wheat flour formed into pipes or tubes. Only the hardest kinds of wheat, which have in them the most GLUTEN, are used in making macaroni. The wheat is ground into a coarse meal, in which state it is called *semola*. The semola is made into a stiff dough by means of machinery, though sometimes in Italy it is trodden out by the feet, and is then forced through holes in the bottom of a cast-iron barrel something like a colander. The barrel is filled with dough, and a plate of iron which just fits into it is pushed down by a powerful press. The paste is thus forced through the bottom, and takes the shape of the holes. For making macaroni the holes are the size of the tube to be made, and have a core, called a mandrel, in the middle, which is fastened on one side, as shown in the picture. The dough comes out of the bottom of the cylinder shaped like a tube, but split open on one side by the little piece which holds the core or mandrel in its place.


Hole for making Macaroni.

Before it goes far, however, the two edges of the paste, which are damp, come together and stick, thus forming a tube. A fire under the cylinder partly bakes the macaroni as it passes through, and it is afterward dried by being hung up on rods. Macaroni is sometimes made into flat ribbons or fillets by being forced through flat holes.

Vermicelli is made in the same way as macaroni, only the dough is a little thicker and is forced through small round holes without any core in them. When about a foot long the pieces are broken off and twisted into different shapes. Sometimes the dough is rolled into thin sheets and stamped out into little stars, rings, letters, figures, and other forms. In this state they are called "Italian paste," and are used in making soups.

Macaroni and vermicelli are made chiefly in Italy, whence they are sent in large quantities to foreign countries. Macaroni is eaten generally cooked with cheese, but is also, with vermicelli, used for thickening soups, and for making puddings.

The word macaroni is in Italian *maccheroni*, which is from *maccare*, to bruise or crush.

Vermicelli is Italian, and means little worms. It is from the Latin *vermes*, a worm.

MACE. See NUTMEG.

MACKEREL, a common sea fish, much used for food. Mackerel are found in all northern seas. They come to the coasts in spring and summer to spawn, and return into the deep parts of the ocean at the beginning of winter. The common mackerel of our coast differs somewhat from the European mackerel, but its habits are much the same. What is called here the Spanish mackerel is also slightly different from the Spanish mackerel of Europe. Mackerel live chiefly on the young of other fishes, and are themselves eaten by the horse mackerel or tunny, the blue fish, and other large fishes.

The mackerel fishery is very important, and great numbers of these

fish are caught yearly both with hook and line and with nets. They swim in shoals or schools just under the surface of the water, their fins often showing above it. They are taken mostly in seines (see NET), which are drawn up alongside a boat, and the fish are then scooped out with a dip net. Seines can be used only in calm weather; when the wind is high mackerel are caught with hook and line. The hooks are usually baited with small pieces of mackerel skin, but mackerel will bite at a piece of white or red cloth, or almost anything which can easily be seen in the water.

The mackerel is supposed by some to be named from the spots on its sides, *macula* in Latin meaning a spot.

MADDER, one of the most useful of all dyes, obtained from the roots of the madder plant, which grows in the warm parts of both the Old and the New World. The roots are dried in stoves or in the sun, threshed to get off the loose skin, and then broken up into pieces or ground fine, and the meal sifted to different degrees of fineness. Madder is used by dyers to make a great variety of colors, especially red tints, and others called madder purple, madder orange, madder yellow, etc. The well-known Turkey red, used in dying cotton goods, is a madder color. The Hebrews did not know the plant, but the Greeks and Romans did.

The word madder is from the Anglo-Saxon *mædere*, the madder plant.

MAGNESIUM, a METAL, one of the ELEMENTS. It is very abundant, but is never found free, that is, alone by itself, and so is somewhat costly; but it can be made by the chemist, and when a cheaper way of making it is found out, it will be very valuable. When pure it is a soft, silver-white metal, which can be hammered out or made into wire. It does not change in dry air, but in moist air soon oxidizes or rusts. When heated very hot it will take fire and burn with a dazzling bluish-white light. Thin narrow ribbons of it are burned where much light is wanted, its light being forty times stronger than gaslight. It is much nearer to sunlight in quality than the electric light. Photographers use it to light up caves and other dark places where sunlight cannot enter. It is also used for making signals and in fireworks.

When burned, magnesium unites with OXYGEN and leaves a white powder, which has neither taste nor smell. This is magnesia (magnesium oxide). It will not melt in any common fire, and is therefore used for making crucibles for chemists. Magnesia united with sulphuric acid makes magnesium sulphate, commonly known as Epsom salts, because found in a mineral spring at Epsom, England.

Magnesium gets its name from Magnesia in Thessaly, whence magnesia is said to have been first brought.

MAGNET, a substance which has the power of attracting or drawing iron to itself. The loadstone, or natural magnet, is a kind of iron ore found in different parts of the world, especially in Sweden, and in the States of New York and New Jersey. If a loadstone be held near to iron filings they will cling to it in a cluster. Many needles may be raised up by it, and even tacks and small nails; and if the loadstone be a large one it will hold up quite a heavy weight. This power which the loadstone has of attracting iron is called magnetism.

The loadstone can give this power to pieces of iron and steel so that they also will attract iron. This is done by rubbing the loadstone several times along a piece of iron or steel, when the iron or steel will become a magnet and have the same power which the loadstone has. A bar of iron or steel to which magnet-

ism has thus been given is called an artificial magnet. Common iron will not keep this power long. But steel will. Magnets are made in different forms, but the most common ones are the straight bar magnet and the horseshoe magnet. Bar magnets are often made by putting several thin bars together in a bundle. Such a one is much stronger than a single bar of the same size, because thin bars can be more strongly and evenly magnetized than thick ones. Horseshoe magnets, which are so called because they are made in the shape of a horseshoe, are also made stronger by putting several thin ones together.

Fig. 1.—Bar Magnet.

The power which magnets have is not equally strong in all parts of their surface. If a bar magnet be rolled in iron filings, the filings will collect mostly about the two ends, as shown in the picture, while in the middle there will be a place where there will be none. The two ends of the magnet, where the magnetic power is strongest, are called the poles. These poles differ from each other, as will be seen if the magnet be balanced on a sharp point so that it may turn in any direction, like the needle in the compass. It will then move round in a line nearly north and south, one end always pointing toward the north and the other end toward the south. For this reason the pole of the magnet which points north is called the north pole, and the one which points south the south pole. If the magnet be turned round so that the north pole points toward the south, it will soon turn back and point toward the north again. This is because the earth itself is a great magnet, having one pole at its north end, which draws the north pole of the magnet in that way. The power of the magnet to turn toward the north is not changed by shutting it up in glass, paper, wood, copper, or anything which has no iron in it. Thus, the COMPASS works just the same when shut up tight in a brass box with a glass over it as if it were in the open air.

If a magnet be cut in two in the middle two magnets will be made, each of which will have a north and a south pole. If these be again divided, other magnets will be formed, each having a north and a south pole, and so on no matter how many parts it may be divided into. If now one of these magnets be placed so that it will turn round on a point, like the compass needle, and the poles of another magnet be brought near to one of its poles, it will be found that the north pole of one magnet will attract or draw toward it the south pole of the other one, but will repel, or drive away, its north pole, and that the south pole of the first one will attract the north pole of the second one, but will repel its south pole. Thus poles of the same kind

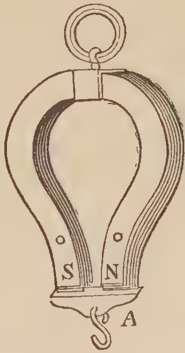


Fig. 2.—Horseshoe Magnet.

repel, while poles of different kinds attract each other. But either pole of a magnet will attract a piece of iron which is not magnetic; and the strongest attraction takes place when both the poles of one magnet can be put on the surface of the piece of

iron. This can be done with the horseshoe magnet, as shown in the picture, where S and N are the south and north poles. Such a magnet is the best kind, either for raising weights or for making other magnets. A magnet does not lose any of its power by giving magnetism to other bodies, but gains power and becomes stronger. But they do lose power if left alone by themselves any length of time. They are therefore usually fitted with a piece of soft iron called an armature (from Latin *armatura*, armor), shown at A in Fig. 2, with a hook below it to hang a small weight on. If the weight be added to a little each day the magnet will slowly grow stronger. This is because the armature itself is turned into a magnet, with its north pole next to the south pole of the horseshoe magnet and the two, acting on each other, add to each other's strength.

Electro-Magnets. Magnets may be made by ELECTRICITY. If a needle of hard steel be laid across a wire through which a current of electricity is passing, such as the wire of a Voltaic battery, the needle will at once become magnetic, one end being a north pole and the other a south pole. A piece of soft iron laid across a like wire will also become magnetic, but will remain so only a short time, while the steel needle will stay so always. The magnet will be made much stronger if the wire be coiled around the iron or steel, as shown in the picture Fig. 3, at A. Such a coil is called a helix (Greek, a winding). To keep the coils of wire from touching each other when thus wound the wire should be covered with silk thread. If the soft iron bar, B, be put loosely inside a helix, and the two ends of the wire, *a* and *b*, be connected with a Voltaic battery, the iron bar will become so strongly magnetized that it will be held up, and it will also hold up a weight hung to it; but as soon as the current of electricity ceases, the magnetism ceases and the bar and weight will drop. Temporary magnets thus made by an electric current are called electro-magnets.

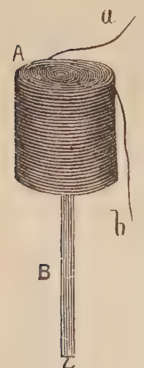


Fig. 3.—Helix and Bar.

The strongest electro-magnets are made by bending a piece of soft iron into the shape of a horseshoe, as shown in the picture, Fig. 4, and then winding round it a copper wire covered with silk thread. If now the two poles of a Voltaic battery (see ELECTRICITY) be joined with the ends of the wires, A and B, one pole being joined to A and the other to B, so that the electrical current will pass through the wire coiled round the horseshoe iron, the iron will at once become very strongly magnetic, so much so that it will hold up the armature C, and a heavy weight fastened to it. Electro-magnets have been made so strong that they could hold up a weight of two tons, or as much as two common loads of coal. But as soon as the connection between

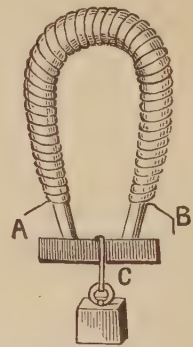


Fig. 4.—Horseshoe Electro-Magnet.

the horseshoe and the Voltaic battery be broken, so that the current through the coiled wire shall cease, the power of the magnet will be lost and the weight which it held up will at once drop.

If a piece of hard steel, instead of soft iron, be wound with a helix of wire, and an electric current be allowed to flow through the wire, the steel will not only be magnetized, but will stay a magnet even after the current ceases. It will then be just like any other magnet, and will draw iron to itself. As this magnet was made by electricity so it may be used to excite or make electricity. If we wind a wire round a magnet, and join the two ends of the wire together, we may make a current of electricity run through the wire by touching the end of the magnet with a piece of soft iron, or even by bringing the iron near the end. The reason of this is, that the iron disturbs the magnetism in the magnet, and any change in the condition or state of a magnet will produce electricity in a wire wound round it. This current, which is called a magneto-electric current, because it is caused by a magnet, will flow through the wire every time that the iron is brought near to and taken away from the magnet. The magneto-electric current has lately been made very useful to mankind, as is told about under TELEPHONE.

The word magnet is from the Latin and Greek *magnes*, loadstone, which was named from Magnesia, in ancient Thessaly, where loadstones or natural magnets were first found.

MAGNOLIA. Most of the shrubs and trees called magnolia belong to North America, though some are found in India, China, and Japan. The principal kinds in the United States are the laurel magnolia or sweet bay, which grows in nearly all the States ; the great-leaved magnolia, which grows south of Kentucky ; and the great-flowered magnolia, which grows from North Carolina southward. The last is an evergreen, and is the most beautiful of all the magnolias. The flowers are large, pure white, and very sweet.

The magnolia was named after Pierre Magnol (1638-1715) professor of botany at Montpellier, France.

MAGPIE, a black and white bird of the crow kind, but with a much longer tail than the crow. It is common in Europe and in the north parts of America, but is not often seen near the Atlantic coast of the United States. The magpie is noted for its cunning, is easily tamed, and may be taught to speak a few words. It is a bold, impudent bird, and will attack a dog, a fox, or any small bird of prey without fear. It chatters all the time, from which comes the saying, to "chatter like a magpie." Magpies build their nests in the tops of high trees, and lay usually seven eggs, of which they take the greatest care, both the male and the female taking turns at sitting.

The magpie belongs to the order *insessores* or perching BIRDS.

The word magpie is short for magot-pie or margot-pie, margot being an abbreviation of Margaret, and *pie*, Latin *pica*, the magpie.

MAHOGANY, the wood of a tree of the same name which grows in South and Central America and the West India islands. The tree is very large, being often five feet thick. The wood is hard, close-grained, quite heavy, and of a rich reddish-brown color, usually with beautiful lines or veins. It is much used for furniture, and for the inside woodwork of railway cars, sometimes solid, but more often as a veneer, or thin layer to be glued on to cheaper wood. Mahogany differs in value according to the color and beauty of its veins. What is called Spanish mahogany, with a figured grain, comes chiefly from Santo Domingo and Cuba. Sometimes single logs have been sold for more than $5000.

The word mahogany is from *mahagoni*, the West Indian name of the tree.

MAIZE. See CORN.

MAMMALS, the first or highest class of vertebrate ANIMALS, so called because they all suckle their young at the breast. Mammals, like birds, are warm-blooded, but they differ from them in being viviparous—that is, they bring forth their young alive, while birds hatch theirs from eggs. They are also generally covered with hair, and never with feathers; but some have a bare skin, as the whale and porpoise; some, wool, as the sheep; some, bony scales or plates, as the ant-eater and armadillo; and some, quills or bristles, as the porcupine and hedgehog.

Mammals are alike in having the body divided into the three parts of head, neck, and trunk. This cannot always be seen in live mammals, but it can in their skeletons; and the neck, although it differs in length from that of man to that of the giraffe, is, with only two or three exceptions, made up of seven vertebræ or joints. Mammals breathe by means of lungs, and never, like fishes, through gills. They differ, too, from fishes in having a double heart, that is, a heart divided into two parts. Most mammals are quadrupeds (four-footed, from Latin *quatuor*, four, and *pes*, plural *pedes*, foot), but in man hands take the place of the fore feet, while in whales, seals, etc., the feet are paddles. Their teeth differ according to the food they eat, some being made for cutting, some for grinding, and others for holding the food while the animal tears it apart. Most mammals have two sets of teeth, the first set coming out and being replaced by a second one, but some never have but one set. Mammals do not change their homes with the seasons, as most birds do, but spend the summer and winter in the same place. Whales are exceptions: they live during the summer in the cold Arctic regions and come south every winter into the warmer waters of the Atlantic.

Mammals have been divided in different ways by different writers, but the following is the most simple arrangement, the class being divided into nine orders:

I. **Bimana,** or two-handed animals. MAN is the only one in this class.

The word bimana is from the Latin *bis*, twice, and *manus*, hand.

II. **Quadrumana,** or four-handed animals, in which are the APES, BABOONS, and MONKEYS. They are so called because they use all their feet like hands. Some writers name this order *pedimana*, or foot-handed animals.

The word quadrumana is from the Latin *quatuor*, four, and *manus*, hand. Pedimana is from the Latin *pes*, foot, and *manus*, hand.

III. **Cheiroptera,** or hand-winged animals, made up of the BATS. They are so called because the bones of the wings are like those in the hand of man, though much longer. These are the only mammals which can really fly, other flying animals, such as the FLYING-SQUIRREL, having no power to fly upward, but being able only to make long leaps from tree to tree.

The word cheiroptera is from the Greek *cheir*, hand, and *pteron*, wing.

IV. **Carnivora,** or flesh-eating animals, so called because they live mostly on flesh food.

The word carnivora is from the Latin *carnis*, flesh, and *vorare*, to devour.

The carnivora are divided into five families:

1. Cats, including the LION, TIGER, LEOPARD, PANTHER, COUGUAR, LYNX, common CAT, and others. These animals have soft cushionlike feet, so that they can get near their prey without being heard, and short strong legs, fitted for leaping. They all have sharp claws, which are shut up when they walk, but which they can thrust out when they wish to use them. Their senses

are sharp, and they can see almost as well by night as by day. Their teeth are made for cutting and tearing flesh, and in their wild state they never eat anything else. In the pict-

Skull of Cat.

ure, which shows the skull of the common house cat, may be seen the way the teeth are set in all the cat family.

2. Dogs, among which are the WOLF, JACKAL, FOX, and common DOG. They are not entirely flesh-eating animals, like the cats, but are fitted to eat vegetables also.

3. Weasels, among which are the WEASEL, ERMINE, SABLE, MARTEN, FERRET, POLECAT, MINK, SKUNK, and OTTER. These mammals have long, slender bodies, all being much like the weasel, shown in the picture, and live in the hollows of trees, holes in walls, or in burrows in the ground, from which they come forth at night in search of game. They are very bloodthirsty, and most of them have a strong smell. The furs of some of them are very valuable. The otters differ somewhat from other weasels, as they always live near the water and feed chiefly on fish.

Weasel.

4. Bears, including the BEAR, BADGER, RACCOON, and others. Bears are called plantigrade animals, because they always walk flat-footed, that is, on the sole of the foot. In this they differ from the families of the cats, the dogs, and the weasels, which always walk on the toes, and are therefore called digitigrade animals. All the bears have five toes, and claws, but the claws are made for climbing trees and for digging in the ground, and cannot be shut up like those of the cats. They are not altogether flesh-eaters, but often eat vegetables.

The word plantigrade is from the Latin *planta*, the sole of the foot, and *gradi*, to walk. Digitigrade is from the Latin *digitus*, toe, and *gradi*, to walk.

5. Seals. The SEALS are said to be amphibious, that is, living a double life, because they live both on land and in water. They feed

Hind Foot. Fore Foot.

Feet of Bear.

chiefly on fishes, but will eat flesh if they can get it. The WALRUS, SEA-ELEPHANT, and SEA-LION are included in this family.

The word amphibious is from the Greek *amphi*, on both sides, and *bios*, life.

V. **Insectivora,** or insect-eating animals, such as MOLES and hedgehogs.

The word insectivora is from the Latin *insectum*, an insect, and *vorare*, to devour.

VI. **Rodentia,** or gnawing animals, so named because their teeth are fitted for gnawing wood, the shells of nuts, and other like hard things. The gnawing teeth are in front, two in the upper and two in the lower jaw. These, unlike the teeth in other mammals, are always growing, but are kept of the right length by the gnawing of the animal, which wears them down. If by any chance the animal loses one of these, the tooth opposite it keeps on growing, and sometimes reaches such a length as to prevent its eating. Rats and squirrels have been known to die from this cause.

The word rodentia is from the Latin *rodere*, to gnaw.

The rodentia are divided into eight families:

1. Squirrels, among which are the common SQUIRREL, ground squirrel or CHIPMUNK, and FLYING-SQUIRREL. They all have thick bushy tails.

2. Marmots, among which are the ground-hog or WOODCHUCK.

3. Rats and mice, among which are the black and the brown RAT, the MUSKRAT, and the house and the field MOUSE.

4. BEAVERS, which have webbed hind feet and a broad flat tail.

5. PORCUPINES, which are covered with an armor of sharp spines.

6. GUINEA PIGS, which look somewhat like a rabbit.

7. CHINCHILLAS, small South American mammals valued for their fur.

8. HARES, including RABBITS. They differ from other rodents in having more than four front teeth.

VII. **Edentata,** or toothless animals, such as the SLOTH and anteater. The sloth climbs trees with its back downward and sleeps hanging from the branches. It is found only in South America. The anteater, which also lives in South America, tears open ANT hills with its claws, and licks out the ants with its long tongue.

The word edentata is from the Latin *e*, without, and *dens*, a tooth.

VIII. **Marsupialia,** marsupials, or pouched animals, named from a kind of bag or pouch that the females have, in which they carry their young for some time after birth. They were among the earliest known mammals, and existed for ages in Europe and America when the great reptiles lived. They are now almost extinct, the only ones left being the KANGAROO, found only in Australia and the neighboring islands, and the OPOSSUM, which lives only in America.

The word marsupialia is from the Latin *marsupium*, a pouch.

IX. **Pachydermata,** pachyderms, or thick-skinned animals, so named from the thickness of their skins.

The word pachydermata is from the Greek *pachus*, thick, and *derma*, skin.

The pachydermata are divided into six families.

1, The ELEPHANT, which is the only mammal having a long proboscis or trunk.

2. The TAPIR, which has a long upper lip somewhat like the elephant's trunk, but much shorter.

3. The Hog, including the common HOG and the wild boar.

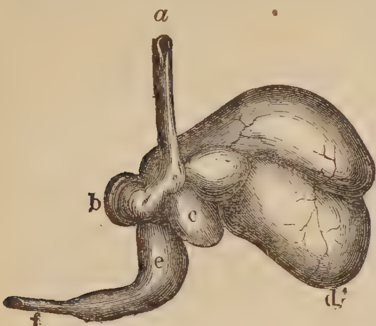
4. The RHINOCEROS, so called because it has a large horn growing out of the end of the nose.

5. The HIPPOPOTAMUS, which is found only in Africa.

6. The Horse, including the common HORSE, the ASS, and the ZEBRA. This family differs from all other mammals in having solid hoofs.

X. **Ruminantia,** ruminants, or cud-chewing animals, so called because

they raise their food from the stomach and chew it. The stomach of ruminants has four separate parts or bags, as shown in the picture, which is the stomach of a sheep. Their food, which is chiefly grass and herbage, is not chewed at once, but is swallowed through the gullet, *a*, into the first and largest stomach, *d*, called the paunch, where it soaks for



Stomach of Sheep.

a while, and then passes into the second stomach, *c*, called the honeycomb bag, because its inside is a network of little cells like a honeycomb. In this the food is made up into cuds or wads, and when the animal is at leisure it brings up each of these, one at a time, chews it, and swallows it again. It goes this time into the third stomach, *b*, called the manyplies, because it has many folds, and thence into the fourth stomach, *e*, called the rennet, which is properly the true stomach. From this it passes off through the intestine *f*. Most ruminants have horns, and the feet of all end in two toes with hoofs.

The word ruminantia is from the Latin *ruminare*, to chew over again.

The ruminantia are divided into seven familes :

1. Bovidæ, among which are the OX (see CATTLE), the BUFFALO of Asia and Africa, the American bison, miscalled buffalo, the MUSK-OX, and others. All of this family have tapering horns, without branches.

The word bovidæ is from the Latin *bos*, an ox.

2. The SHEEP, of which there are many kinds.

3. The GOAT, including the common, the Angora, and the Cashmere goat, the ibex, and others.

4. The Deer, among which are the common DEER, the REINDEER, the ELK, and others. They all have branching horns, which are shed usually every year.

5. The Musk-deer which looks like a deer, but is smaller, and has no horns. The perfume MUSK is obtained from one of this family.

6. The ANTELOPE, of which there are many kinds, including the gazelle and the chamois. They look like the deer, but they do not shed their horns.

7. The Camel, including the true CAMEL, the dromedary, and the LLAMA.

8. The GIRAFFE, or camelopard, which is found only in Africa.

XI. **Cetacea**, among which are the true WHALES, baleen, and sperm whales, and the dolphins (DOLPHIN, PORPOISE, GRAMPUS, and NARWHAL).

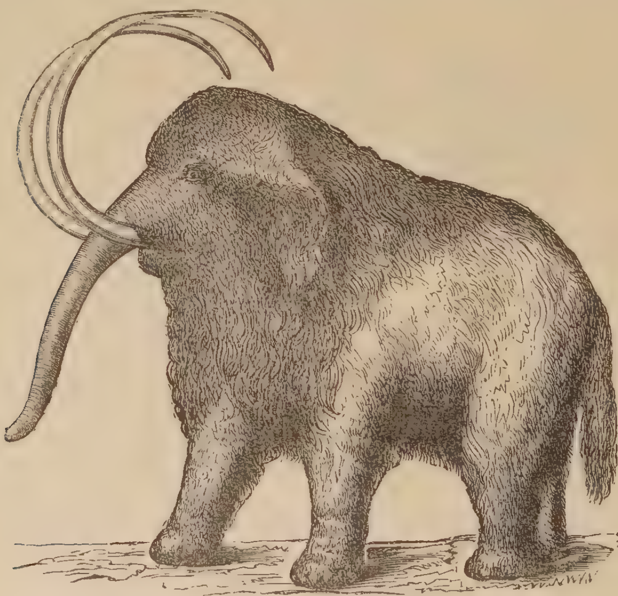
The word cetacea is from the Latin *cetus*, a whale.

The word mammal is from the Latin *mamma*, breast.

MAMMOTH, the name commonly given to the fossil elephant, whose remains are found in frozen regions. It formerly ranged in great herds over Northern Europe, Asia, and America. It was about as tall as the elephants of the present day, but was stouter, more clumsy, and heavier. The skin was thick like that of the elephant, but it was covered with coarse brown hair, much like horsehair, twelve or fifteen inches long, with a shorter yellowish woollike hair at its base, giving the animals a warm covering suited to a cold climate. The tusks were longer than those of our elephants, and more curved. The mammoth has not lived for ages, but many have

been found frozen in the ice in Siberia in so good a state of preservation that their flesh has been eaten by dogs and other animals. Their tusks are so plentiful in Siberia, and in the islands off the coast, as to make an important trade in ivory. It is supposed that the mammoths were overwhelmed and destroyed during the glacial period.

MAN, the first and principal order of MAMMALS, which form the first class of vertebrate ANIMALS. Man is put at the head of the animal kingdom because he is the superior of all animals. He is the only animal that always walks erect, the only one that may truly be said to have a hand, and the only one that talks. It is true that monkeys can stand erect or nearly so, and that they use their fore feet sometimes like hands; but they usually walk on all fours, and their hands are



Mammoth.

fitted for only a few motions, while those of man are adapted to almost every kind of movement. Parrots too, and some other birds, can be taught to speak, but their words are only imitations of those of man, and they cannot make language. In some things man is inferior to other animals: he cannot swim as well as fishes can; he cannot fly like birds; he cannot run, nor jump, nor climb, as well as many quadrupeds and insects; but he can do a greater number of things than any other animal. It is not, however, in his body that man chiefly excels all other animals, but in his mind, which enables him to reason and to use his limbs and his faculties. The mind is seated in the brain, and man therefore has a much larger brain, considering the size of his body, than any other animal; and his system of NERVES, which is connected with the brain by means of the spinal marrow, and which radiates from it,

or stretches in all directions, like a series of white threads, to every part of the frame, is much more perfect than in any other living being.

Mankind has been divided by different writers in several different ways, some classing men according to the shape of their skulls, some according to the color of their skins, and some according to their hair; but the most usual classification is into five great families or races, as follows:

I. **Caucasian** or white race, so named from the Caucasus Mountains in Asia, near which they are supposed to have first lived. This family is the most powerful and best civilized of all the races, and includes nearly all the great nations known in history. It now occupies all of Europe, a large part of Western and Southern Asia, Northern Africa, Australia, and most of North and South America.

II. **Mongolian** or yellow race, so called from Mongolia, now a part of China, where they came from. They live now mostly in China and Japan, and in Northern and Eastern Asia.

III. **Ethiopian** or black race, so called from Ethiopia in Africa, which once was a much larger country than it is now. This family live chiefly in Central and Southern Africa.

IV. **Malay** or brown race, named from the Malay Peninsula in Southern Asia. This family live now in Southeastern Asia and in most of the islands of the Indian Archipelago and of the Pacific.

V. **American** or red race, made up of the Indians of both North and South America.

All these families may be subdivided into many kinds, some of which differ greatly from each other. Thus the features of the Jew are very marked, and the American or Englishman is easily told from the German and the Irishman.

Notwithstanding these great differences in the families of mankind, most writers think that all men had a common beginning, and are descended from one pair of parents, who lived many thousand years ago; but there are some who deny this, and who believe that each family of mankind is separate and had a separate pair of parents of its own, and therefore that there is no blood relationship between the different families. Other writers believe that man is descended from an animal something like the ape. It is not thought that any of the now living apes was the ancestor of man, but that some former kind grew little by little both in body and in mind until it became like man, and afterward advanced through many ages of growth to man's present condition.

But whatever was the origin of man, it is now proved that he lived on earth thousands of years ago, at the same time with many animals that have long been extinct. Man is known to have lived at least as early as the quaternary epoch of the EARTH, in what is called the glacial period, when a great part of Europe and America was covered with ice, when the British Islands were joined to the mainland of Europe, when Sicily was joined to Africa, and Africa to Europe at Gibraltar. At the same time lived the hairy mammoth, the woolly rhinoceros, the cave bear, the cave hyena, the cave lion, and the Irish elk, all of which are now extinct, and are known only by their bones, found in CAVES or buried in the earth. We know this from finding the bones of man mixed with their bones, together with flint and bone tools and weapons. Man was then a savage much like the Eskimo of to-day, living by hunting and fishing and clothed with the skins of wild beasts. He dwelt in caves, in the hollow trunks of trees, or even in sheltered places among rocks, ate raw the flesh of the animals he killed, and sometimes it is feared, the flesh of his fellow man.

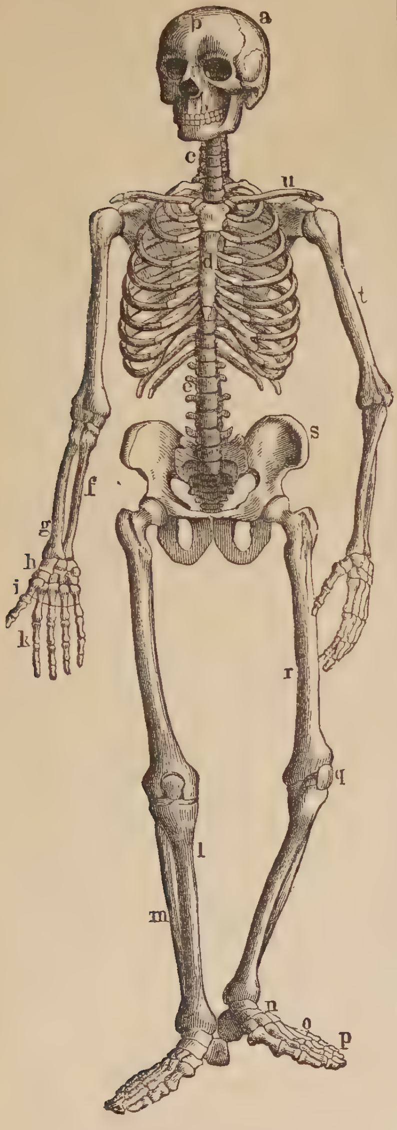
He dropped the bones and shells of his food where he ate it, and thus grew up in time the great deposits in CAVES, under the LAKE-DWELLINGS, and in the heaps called KITCHEN-MIDDENS, which have preserved for us all we know of his history.

Prehistoric Man. When man began to be civilized, long before the historic period when he began to keep records, he passed through three stages of growth, commonly called ages: the Stone Age, the Bronze Age, and the Iron Age. These ages cannot be separated one from another, like periods of time, for they sometimes overlap one another; nor have they been in all places and at all times alike; the Stone Age in Europe passed away before history began, but there are savage tribes on earth who are still in their Stone Age. These terms are used, then, only to mark different stages in man's civilization. When man first entered into the Stone Age he made tools and weapons out of roughly chipped flint stones, but he soon learned to grind and to polish them, and in some cases to ornament them; so some writers divide the Stone Age into two parts—the rough stone age and the polished stone age. It was in this age that man began to till the soil and to tame the animals which have ever since been his servants and companions. In the Bronze Age he made tools and weapons out of a mixture of about nine parts of copper and one part tin. This alloy, which is harder than iron, through not so hard as steel, made very good knives and swords, far better than those of flint. It is probable that man used pure copper before bronze, and some writers make a Copper Age between those of stone and iron. This was certainly the case with the mound builders in America, who hammered out the soft copper of Lake Superior before they learned to harden it. After a long time man found out how to smelt iron, which then took the place of bronze and the Iron Age began. Thus man went on through different stages of civilization, gaining knowledge little by little and conquering one after another the problems of nature until he became as he is to-day—the ruler of the world and of all things in it.

Body of Man. The body of man is covered with SKIN, under which is what is commonly called flesh, but which is rightly called muscle. Muscle can easily be divided into little slips or shreds, each one of which is fastened tight at its ends, but is loose in the middle. Each one of these slips is called a MUSCLE. Between the muscles lie little white threads called nerves, and also many blood-vessels called veins and arteries. Under the muscles in most parts of the body are the bones, all the different parts of which are shown in the picture of the skeleton of a man. The body is made up of, 1, the Trunk, 2, the Head, and 3, the Arms and Legs.

1. The Trunk is hollow from the neck to the legs, and is divided into two parts by a partition running across it called the diaphragm. The part below the diaphragm is larger than the one above it, and is called the abdomen or belly. In it are the liver and the STOMACH, and below them the intestines or bowels are coiled up in many folds. Under the bowels, in the back part of the abdomen are the two kidneys. The smaller part of the trunk, above the diaphragm, is called the thorax or chest. In the middle of it lies the heart, and on each side of the heart are the two LUNGS.

The human trunk then is a long rounded box to hold the inner parts or organs of the body, which, taken together, are called the viscera. In front it is covered with only muscle and skin; but if there were nothing but soft material all around, it would not keep its shape, so it is held up by the backbone (*e*) behind, and in



Skeleton of Man.

a, Parietal bone or side bone of skull; *b*, Frontal or forehead bone; *c*, Vertebræ of the neck; *d*, Sternum or breastbone; *e*, Spinal column or backbone; *f*, Radius; *g*, Ulna; *h*, Carpal or wrist bones; *i*, Metacarpal bones or bones of the middle hand; *k*, Bones of the fingers; *l*, Tibia or shinbone; *m*, Fibula; *n*, Tarsal or ankle bones; *o*, Metatarsal or instep bones; *p*, Bones of the toe; *q*, Kneepan; *r*, Femur or thigh-bone; *s*, Hip bone; *t*, Humerus or arm bone; *u*, Collar-bone.

the chest the sides are straightened by the ribs. These are thin hoops of bone made fast to the backbone behind and meeting in front in the breastbone (*d*), made up partly of bone and partly of gristle, and named the sternum.

The backbone is not one bone, but a pile of twenty-four bones put one above the other, and so jointed together that each one can turn on the other. If this were not so, the body could not bend, but would be stiff. Each one of these joints is called a vertebra, and is formed like the one shown in the article ANIMAL. When all the joints are fitted together, the holes in each come one above the other so as to make a long tube, called the spinal canal, because the spinal cord, which leads from the brain, passes through it. On the top of this column of bones rests the head. The upper bone of the part of the backbone called the neck vertebræ (*c*) has two places hollowed out in it, and on the bottom of the head are two little rockers which fit into them so that the head can move easily.

2. The Head is a roundish box of bone, covered over with flesh and skin. The bony case, which is called the skull, is made up of several bones, only two of which are shown in the picture, but is all in one piece, with the exception of the lower jawbone, which is so joined to the upper jawbone that it can be opened and shut. The upper jawbone does not move at all except when the whole head moves. The opening between the two jawbones is the gape of the mouth.

In the jawbones are set the teeth. The teeth are like the bones in some things, but they do not grow like them. The bones grow with the rest

of the body, but teeth are never any larger than when they first come through the gums. This is because the outside of the teeth, or the enamel, as it is called, has to be very hard, so that they can cut and grind the food; and this enamel when once made is finished, and does not grow any more. If the first teeth should stay in the head they would be too small when the person grows up, and as the jaws grew they would be far apart instead of close together. So the first ones begin to be shed about the seventh year, and a new set, larger and more in number, take their place little by little, but the second set does not become full until the person is nearly of age.

There are only twenty teeth in the first set, ten in each jaw, but the second set when full has thirty-two, or sixteen in each jaw. Teeth are divided into incisors, canines, and molars. The incisors (Latin *incidere*, to cut in), or cutting teeth, are the four front teeth in each jaw; the canines (Latin *canis*, dog), so called because they are very long in the dog, are the two sharp-pointed teeth which grow one on each side of the incisors; the molars (Latin *mola*, a mill) are all the teeth back of the canines, and are used to grind the food.

The skull has a rounded hole in its underside, and when it is set on the top of the backbone this fits directly over the spinal canal, so that if a long wire were to be pushed up from the bottom of the backbone through the canal it would go right up into the hollow part of the head. In this hollow of the head is the brain, which tapers off at the bottom and runs down the canal in the backbone, forming the spinal cord. On each side of the skull is an opening for the canal of the EAR, and in front are two rounded hollows called orbits for the EYES, and an opening for the nose.

Between the head and the trunk is the neck, through which the backbone passes. In the front part, besides muscles, nerves, and blood-vessels, are two tubes, the trachea, commonly called the windpipe, and the œsophagus, commonly called the gullet. These tubes both lead from the throat, which divides into two in the upper part of the neck. The windpipe, which is made firm by hardish rings in it, ends in the lungs, but the gullet, which is soft so that its sides lie flat together, runs down through the chest, lying close to the backbone, and passing through a hole in the diaphragm enters the abdomen, where it widens out into the stomach. At the lower end of the stomach it narrows again into the intestine, and, after winding about a good deal in the lower part of the abdomen and forming the bowels or intestines, finally leaves it. This long tube, made up of the gullet, stomach, and intestine which thus goes entirely through the body without opening into it, is called the alimentary canal.

3. The Arms and Legs have no hollow parts, but are made up of a framework of bones covered with flesh and skin. The arm is made up of the upper arm, which is rightly called the arm, the lower or forearm, the wrist, and the hand. The bones of the arm are made up of one rather large bone (*t*) reaching from the shoulder to the elbow, and of two bones in the forearm. The bone in the upper arm is called the humerus. It is fastened to the shoulder-blade by such a joint that it can turn in any way. The shoulder-blade is jointed in front with the collar-bone (*u*), which makes a kind of brace for it. Of the two bones in the forearm the one which is largest at the elbow is named the ulna (*g*), and the one which is largest at the wrist the radius (*f*). The end of the humerus at the elbow is rounded, and the same end of the ulna is scooped out so that the humerus fits into it. This makes a joint, but

such a one that the ulna can move only up and down and not sidewise. It can shut up so as to lie flat against the front of the humerus, and can be straightened out, but cannot be bent backward. The radius, the other bone of the forearm, is so made that its end at the elbow moves over both the end of the humerus and the end of the ulna, so that they both move together when the arm is raised or lowered; but it has also another motion, by means of which the forearm may be turned round so as to bring the palm of the hand up or down.

Although all these bones are fitted into each other so as to make hinges, they would fall out of their places if they were not fastened there. In a dried skeleton they are usually fastened with wires or strips of brass, but in the arm of a live person the bones are joined together with flat thin bands called ligaments, which hold them firmly in place, but let them move easily. The ends of the bones are made smooth by a kind of gristle which grows all over them, and which is kept always moist by a kind of fluid, just as the ball of the eye is kept moist by tears. Two bones thus fitting into each other, their ends being made smooth with gristle and kept moist, and being held in place by ligaments, form what is called a joint. There are many other joints in the body, but, although they differ from each other in some things, they all work in much the same way. To bend the arm, or to work any other part of the body, some force must be used; this force is told about under MUSCLES. The wrist and hand are made up of twenty-seven bones, which work together in many different ways so that the hand can make a great many movements and do almost anything it is wanted to do. The parts can be seen in the picture, marked *h*, *i*, and *k*.

The leg is made up of the thigh, the lower leg, which is rightly called the leg, the ankle, and the foot. The hip bones, to which the leg bones are joined, are fastened tight to the lower part of the backbone. On the outside of each hip bone (*s*) is a round socket or hollow, in which fits the head of the thigh-bone (*r*). This bone, which is named the femur, is the largest and strongest one in the body. Its lower part is made much like the elbow end of the humerus, and it is jointed with the principal bone of the leg (*e*), commonly called the shinbone, but rightly called the tibia, which holds up the whole weight of the body. The fibula (*m*), or small bone of the leg, lies on the inner side of the tibia. It does not help to hold up the body, but it is so fastened to the tibia that it helps it to move. Over the joint of the knee is a little flat bony cap (*q*) called the knee-pan, one of the uses of which is to keep the joint from being hurt. Like the hand and wrist, the ankle and foot are made up of many different bones (twenty-six in all), the general form of which can be seen in the picture. This is not because the foot has as many movements as the hand, but because it needs to be very loose and springy, so that one can walk, run, and jump easily. If it were all one bone, it would be stiff and clumsy.

Nearly all parts of the body are filled full of blood-vessels and nerves. The blood-vessels come from the heart, the NERVES from the brain; so that the heart and the brain are the two great centres of the body, Everything in the body is made from the BLOOD, and in the brain is the mind, which does all the thinking and gives to man all his senses.

The word man is from the Anglo-Saxon *man* or *mon*, man.

MANATEE or **SEA-COW**, a sea MAMMAL formerly included among the cetaceans or whales, but now put in an order called sirenoids, between pachyderms and cetaceans. The manatee has a grayish-black fish-like body like that of the whales,

with a broad rounded flat tail, and two front fin-like limbs, used for swimming and for crawling up muddy banks. Its head is conical, with a nose much like a cow's, with bristly tufts of hair on the upper lip. It lives on sea-shores, about the mouths of rivers, and in rivers, and feeds on seaweeds and other sea plants. Manatees are generally about 12 feet, but sometimes 15 to 20 feet, long.

The **Florida Manatee,** the best known kind, inhabits the Gulf of Mexico and the West Indies. It was once abundant on the coast from Key West westward, but it is now seldom seen, though occasionally taken in the Florida rivers. Its flesh is much liked for food.

The **South American Manatee,** which is not quite so large, is found at the mouths of the rivers of Brazil and Guiana. Its flesh, which is like veal, is much eaten on fast days, as it is considered fish by the Roman Catholics. Good oil is made from its blubber and excellent harnesses and whips from its hide.

The word manatee, in Spanish *manati*, is probably from the Indian name of the sea-cow.

MANDOLIN, a stringed musical instrument, like a lute. The body which is shaped underneath like a shell, is formed of several pieces of wood bent into shape; the upper or flat side is the sounding-board, and it has a finger-board with frets on a neck like a guitar. The mandolin has four to six double or single strings, and is played with a plectrum of tortoise shell held in the right hand while the left hand makes the notes on the finger-board. It is used chiefly for accompaniment, but several mandolins played together make very sweet music.

The word mandolin is from the Italian *mandolino*, the diminutive of *mandola*, *mandora*, or *pandora*, a kind of lute.

MANGANESE, a metal, one of the ELEMENTS. It is not found as a metal, but only in the form of oxides (see OXYGEN). When pure it looks somewhat like cast-iron, is grayish-white and brittle, and rusts quickly in the air. It is used in the arts chiefly when alloyed with other metals. Mixed with iron and steel, manganese renders them harder and more elastic; with copper it makes an alloy like that of copper and tin, and with zinc an alloy like nickel silver. Manganese bronze is hard and of the color of gun metal. An alloy of manganese with aluminum is hard enough to scratch glass. Some of the salts of manganese are used in calico printing, painting, and in making enamels for pottery.

The word manganese is altered from magnesium, a name first given to this metal, but now used for another metal.

MANGO, the pickled green fruit of the mango tree, which first grew in the South of Asia. It is now cultivated in India, Ceylon, Persia, and in the hottest parts of Africa and America. The fruit, which is orange-colored when ripe, is about as large as a goose egg, and contains a large flattened stone with a delicious sweet pulp around it. It is much used as a dessert in hot countries, and is sometimes preserved as a sweetmeat in the West Indies. The green fruit is pickled and spiced in the East Indies, and sent to foreign countries.

The word mango is from *mangga*, the Malay name of the mango tree.

MANILA, or **MANILA HEMP** (so called because brought mostly from Manila, in the Philippine Islands), a material made from the threadlike strips, called fibres, of a kind of banana or plantain tree, which grows in the Philippine Islands. The leaf stalks, from which the fibres are taken, are pulled off and beaten with wooden clubs. The fibres are afterward hackled like FLAX, and then carefully sorted, the coarse ones being used for cordage, etc., and the fine ones for weaving. Ropes and cordage made of manila are very

strong and lasting. Fine cloths, such as napkins, veils, muslins, etc., are woven out of the finer fibres, some so fine that one can almost see through them. Much PAPER is made from old manila rope.

MAPLE. There are many kinds of maple trees, some of which grow in North America, some in Europe, and some in Asia. Some are small shrubs, and others are large trees. There are about ten kinds in the United States, of which the most common are the sugar maple, the red or swamp maple, and the white or silver maple.

The **Sugar Maple** is found mostly in the Northern and Middle States. It is a very handsome shade tree, and in the autumn its leaves show many beautiful colors. Its wood ranks next to hickory for fuel, and it makes the best of charcoal. Some of it is straight-grained, and is used for making lasts for shoes, shoe-pegs, buckets, and many other articles; and some kinds, called curled and bird's-eye maple, because its grain is twisted or marked like bird's eyes, are used in cabinet work. The sap of the sugar maple is very sweet, having in it the same kind of sugar as in the SUGAR-cane, and from it maple sugar and maple syrup are made. As soon as the sap begins to flow in the spring, often as early as February, holes are bored into the trunks of the trees a little way above the roots, and little pipes, made often of ELDER, fitted into them. The sap, which flows out through the pipes drop by drop, is caught in buckets, and boiled down in great kettles until most of the water in it passes off in steam, and that which is left is thick like syrup. Some of this is put up in tin cans and sent to town for sale, and some is boiled down still more until it is so thick that when it cools it will turn to sugar. That to be made into sugar is poured into pans of different shapes, some round, some square, and some scalloped, like the cakes of maple sugar seen in stores. The most maple sugar is made in Vermont, New York, and Ohio, but a good deal is made also in New Hampshire, Pennsylvania, and Indiana. The Indians knew the value of maple sap, and taught Europeans that sugar could be made out of it. They used to collect the sap in large birch-bark vessels, let it freeze overnight, and in the morning throw out the ice. This took out some of the water, and they evaporated the rest by putting hot stones into the vessel. The collecting of sap and the making of sugar formed one of their annual religious celebrations.

The **Swamp Maple**, sometimes called red maple, grows mostly in damp woods and swamps. In the autumn it is one of the most beautiful of our trees, its leaves showing all the shades of orange, scarlet, and crimson. Its wood is not so good for fuel as the sugar maple, as it is softer and burns quicker. It is used for gunstocks, lasts, and cheap furniture, and its bark for making a black dye.

The **Silver Maple**, or white maple, which gets its name from the silvery whiteness of the under side of its leaves, is sometimes called, also, the soft maple, on account of the brittleness of its branches. It is not found very near the Atlantic coast, but is common throughout the Mississippi Valley and westward to the Dakotas and the Indian Territory. It is much prized for planting on the prairies, as it grows quickly, and makes a fine shade tree. The wood is hard, strong, close-grained, and valuable, excellent for the floors of houses, furniture, etc.

The Saxons called this tree *mapel-treow*, and our name for it has grown out of this word through several changes.

MARBLE, a fine kind of limestone used chiefly for building and for sculpture. It is properly a carbonate of lime (calcium carbonate), being made up of CALCIUM, CARBON, and

OXYGEN. It is easily burned, like other limestone, into lime, is soft and easy to work with the chisel or hammer, and is generally of even grain, so that it can be split with wedges. Though all marble is made up of the same things, it is of many different kinds, some being coarse-grained and fit only for building, and others fine-grained enough for making statues and the most delicate ornaments. Some kinds, too, are very lasting, while others are soft and easily crumbled into pieces by the weather.

Marble is among the most beautiful of all stones, being found of all colors, and often marked with stripes, spots, and shades of many different tints. White, gray, yellow, red, blue, green, brown, and black marbles have been used in architecture from the oldest times, and many of the quarries opened by the ancients are still worked. The most noted of the ancient white marbles were the Parian, named from the island of Paros, where it was found, and the Pentelic, quarried on Mount Pentelicus, near Athens. Many of the finest of the Greek statues were made of these marbles, and most of the famous temples in Athens were built of Pentelic marble. The Parian quarries are not now worked, and only a little marble is taken from Mount Pentelicus. Most of the marble used now for making statues is brought from Carrara in Italy, where the quarries have been worked since the time of Julius Cæsar; but very good statuary marble is found in Vermont, and in other States of the United States.

The most noted of the ancient colored marbles are those called by the Italians *nero antico* (black antique), *rosso antico* (red antique), *verde antico* (green antique), and *giallo antico* (yellow antique). Nero antico is the blackest of all marbles, other black marbles looking gray when put beside it. It is not known where it was quarried. Rosso antico is deep red marked with layers of white and fine black veins. It is supposed to have come from Greece. Verde antico is green beautifully marked and shaded with white. It was quarried in Thessaly. Giallo antico is sometimes cream yellow and sometimes bright yellow shading into red and purple hues. We do not know where it was quarried, but some think in North Africa. The ancients used also many other very beautiful marbles to ornament their buildings with, some of which are known only through pieces picked up among the ruins of cities.

In modern times a great number of new quarries have been opened in all parts of the world, and although we do not know where the ancients got some of their most noted marbles, we have many others which are scarcely inferior to them in beauty. The most beautiful colored marbles in the United States are found in Vermont, though fine kinds of different colors are quarried in Maryland, New York, Pennsylvania, and Massachusetts.

Marble is so much more valuable than common building stone that much more care is taken in quarrying it. It is never blasted out with gunpowder, but is usually carefully split out in square blocks by means of wedges. These blocks are afterward sawn up, with toothless iron saws fed with sharp sand and water, into slabs of the size wanted. Slabs for building houses are usually sawn only five or six inches thick, and then set against a brick back; this looks as well as a wall of solid marble, and is much cheaper. Slabs for mantels, table tops, and ornamental work are sawn in the same way, and then carefully ground down smooth with fine sand and PUMICE, and polished with rubbers of woollen cloth and putty powder and water.

The word marble is from the Anglo-Saxon *marmar*, Latin *marmor*, marble.

MARBLES are named from the

Latin word *marmor*, marble, probably because they were first made of marble. Some marbles are made of potter's clay and baked in an oven, just as earthenware is baked, but most of them are made of a hard kind of stone, found in Saxony, Germany. Marbles are manufactured there in great numbers, and sent to India, China, the United States, and other countries. The stone is broken up with a hammer into little square pieces, which are then ground round in a mill. The mill has a fixed slab of stone with its surface full of little grooves or furrows. Above this a flat block of oak wood, of the same size as the stone, is made to turn round rapidly, and, while turning, little streams of water run in the grooves and keep the mill from getting too hot. About a hundred of the square pieces of stone are put into the grooves at once, and in a few minutes are ground round and polished by the wooden block.

Marbles are also made out of china and of white marble. Such ones are usually called by boys "chinas," or "alleys." Real china ones are made of porcelain clay, and baked like china-ware or other POTTERY. Some of them have a pearly glaze, and some are painted in bright colors which will not rub off because they are baked in just as are the pictures on plates and cups and saucers. Marble alleys are also painted sometimes.

Glass marbles, usually called "agates," are made of both clear and colored glass. Clear glass marbles are made by taking up a little melted glass on the end of an iron rod and making it round by dropping it into an iron mould which shapes it, or by whirling it round the head until the glass is made into a ball. Sometimes the figure of a dog, squirrel, or other animal is put on the end of the rod, and when it is dipped into the melted glass the glass flows all round it, and when the marble is done you can see the animal shut up in it. Colored glass marbles are made by holding a bunch of glass rods of different colors in the fire until they melt; then the workman twists them round into a ball, or presses them in a mould, so that when done the marble is marked with bands and ribbons of color.

Real agates, which are the handsomest of all marbles, are made mostly at Oberstein in Germany, of the stone called AGATE. The workmen chip the pieces of agate nearly round with hammers, and then grind them round and smooth on grindstones.

MARCH. See CALENDAR.

MARJORAM, a plant, some kinds of which are used as a seasoning in cookery. The most common kind is the sweet marjoram, which came from Asia and North Africa. Its leaves and buds are dried and powdered and used to flavor soups, stews, and stuffings.

The word marjoram is from the New Latin *majoraca* which is from the Old Latin *amaracum*, Greek *amarakon*, marjoram.

MARMALADE, a kind of preserve made by boiling fruits, such as oranges, pineapples, and quinces. The most common kind is orange marmalade, made usually from the bitter or Seville orange. The rind is first boiled enough to get off the white inside part, and the outside part is then cut up and boiled with the juice of the orange, which has been squeezed out of the pulp, and an equal weight of sugar. Orange marmalade is largely made in Dundee, Scotland, and shipped from there to foreign countries.

The word marmalade is from the Portuguese *marmalada*, from *marmelo*, a quince, probably because marmalade was first made from quinces.

MARMOT, an animal of the squirrel family, inhabiting the mountains of Europe near the snow line. It is about 18 inches long, with a bushy tail

of $2\frac{1}{2}$ inches and with yellowish-gray fur, the top of the head dark gray. Its form is clumsy and its movements slow. Marmots live in families in burrows, a narrow gallery five or six feet long leading to a circular cham-

Marmot.

ber, lined with dried grass. In this they pass the winter in a state of lethargy. Their food is wholly vegetable, and when fat they are sometimes eaten by the mountaineers. The American marmot is the WOODCHUCK.

The marmot is a *mammal* of the order *rodentia*, or gnawing animals.

The word marmot is from the Italian *marmotto*, from Latin *mus montanus*, mountain mouse.

MARS, one of the planets of the solar system (see UNIVERSE). It is about half as far again from the sun as the earth (141,500,000 miles), and the next planet to the earth in the order from the sun. Mars is easily told from the other planets by its red color. Its diameter is about half that of the earth (4200 miles), so that it is about six times smaller. It goes round the sun once in a little less than two years (687 days) and revolves on its own axis in nearly the same time as the earth (24 hours, 37 minutes, 22 seconds), so that its days and nights are of about the same length as ours. Mars was not known to have any satellites or moons until 1877, when Prof. Hall, of the Naval Observatory, discovered two. They are quite small, the outer one being about six miles and the inner one seven miles in diameter. The outer one goes round Mars once in 30 hours, 16 minutes, and the inner one once in 7 hours, 38 minutes. So the inhabitants of Mars may see their inner moon in all its phases in one night.

Mars is one of the most interesting of the planets seen through a telescope. Its surface appears to be made up of reddish and greenish parts, supposed to be land and sea, with each pole covered with white, like the snow and ice on the earth. As these white masses diminish in summer and increase in winter, it is thought that the seasons follow each other as with us, and that the atmosphere of Mars is like that of the earth and is acted on by the sun in the same way. The so-called land in Mars occupies about three-fourths of its surface and the water only one-fourth; but what is strange is that the land is intersected or divided by what appear to be many straight streams or canals, or rather double canals, for almost everyone has a parallel one beside it. Whether these are natural or are the result of skill and labor we do not know, but astronomers hope that we shall some day have telescopes strong enough to solve the problem.

Mars, which was one of the planets known to the ancients, was named from the god of war, perhaps on account of its red color.

MARTEN. The pine-marten, or American sable, as it is more rightly called, is found in the more northerly parts of North America, especially in the thick pine woods. It looks much like the weasel (see MAMMALS), having a slim body, bushy tail, and short legs. Its general color is rusty yellow, with darker marks on the back. In winter its fur is very handsome, and it is then much hunted. It is usually caught in traps baited with a piece of fresh meat, and which are so made that a heavy board falls and kills the animal. Its fur is prized next after that of the

sable, and it is sometimes dyed and sold for Russian SABLE.

The pine-marten of Europe is much like the American pine-marten, but is thought to be a different animal, though of the same family.

The marten is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family.

The word marten is from the Anglo-Saxon *mearth*, marten.

MARTIN, an American bird, of the swallow family, but larger than the swallow. The most common kind is the purple martin, whose color is blue black with purple shades. Martins are found in the most southerly parts of the United States in February, appear in the Middle States and New England in April, and begin to go south again in August. They return every year to the same places and build their nests in the little boxes that are usually set up for them around farmhouses and in villages. They lay four to six white eggs, and usually raise two broods each year. In England the swallow is sometimes called martin, after Saint Martin.

MASTIC, the gum of the mastic plant, a shrub which grows around the Mediterranean. The shrub is sometimes twice as high as a man. In July and August the gum comes through the bark and hardens in little tear-shaped lumps, which are picked off. The Turkish ladies chew it because they think it makes the breath pure and preserves the teeth. When mixed with oil of TURPENTINE it makes a fine varnish, which is much used for varnishing oil paintings.

The word mastic is from the Greek *mastiche*, which is from *mastizein*, to chew.

MASTODON, the name given to a large animal not now living, whose bones are found in all parts of the earth excepting Africa. The French naturalist Buffon, who thought that this animal was eight times as large as the elephant, named it the "elephant of the Ohio," some of its bones having been found near that river in 1739 by a French officer. The Indians, who had traditions about it, called it the "father of the ox," and said that it used to live in the old times with a race of giant men, but that the Great Spirit got angry with them and killed them both with his thunders. Many mastodon remains have since been found in America and many museums have now full skeletons of this great animal, which probably disappeared in the glacial period. The mastodon was a little larger than the elephant of the present day, the body being longer and the limbs heavier and clumsier. It had long, straight, sharp tusks, and probably a trunk. Its food, like the elephant's, was vegetable.

In early times, when the existence of such animals was not known, large bones found were supposed to be those of giants. In 1613, a skeleton, dug up in a sand-quarry in Dauphiny, France, was bought by a surgeon named Mazuyer, who gave out that he had discovered it in a brick tomb thirty feet long and fifteen feet wide, inscribed "Teutobocchus Rex" (King Teutobocchus). This king was a barbarian who invaded Gaul at the head of the Cimbri, and was defeated by Caius Marius in the year 102 at Aquæ Sextiæ, now Aix in Provence. The skeleton, about twenty-five feet long, was exhibited all over France and Germany by Mazuyer, and Louis XIII. took great interest in the supposed remains of this giant king. The skeleton was kept in the Museum of Bordeaux until 1832, when it was sent to the Museum of Natural History in Paris, and was there found out to be the bones of a mastodon.

The word mastodon is from the Greek *mastos*, nipple, and *odous*, tooth, and the animal was so named from the form of its teeth, which look like teats.

MAT, a woven fabric of rushes, straw, husks, rope, or other material.

Mats are now mostly made of hemp rope, but some are of India-rubber. What are called bass or bast mats is a kind of matting made in Russia and Sweden from the inner bark of the linden tree. They are used mostly for packing furniture, covering tender plants in gardens, etc.

The word mat is from the Anglo-Saxon *meatta*, Latin *matta*, a rush mat.

MATCH. The first matches were little sticks of white pine wood with their ends dipped into melted SULPHUR or brimstone. These, which were called brimstone matches, would not take fire by rubbing, but were lighted by sparks made by striking fire with a flint and steel into tinder, or linen rags scraped fine. The next kind were dipped in chlorate of POTASH and some other things, which took fire when touched with SULPHURIC ACID; so every box of matches sold had a little vial of sulphuric acid in it. About fifty years ago (1829) an English chemist found out how to make lucifer matches, which would take fire when rubbed, and since that time the making of matches has become an important business.

Matches are made out of clear white pine. The wood is sawed up into blocks, and the blocks are then forced endwise through thick steel plates filled full of little holes, each just the size of a match, and made sharp at the edges so as to cut. In England only round matches are made in this way, the square ones being split by two sets of little knives, one set working up and down and the other crosswise; but in the United States square matches are made by forcing the wood through square holes. The splints are then dipped into sulphur, and afterward into PHOSPHORUS mixed with some other things. Sometimes thin wax-tapers are used instead of wood splints for making matches, and some matches are made without sulphur.

Safety matches have the substances which make them take fire in two parts, neither part of which will burn unless it is rubbed on the other. For instance, the match itself will have only potash on the end, while the phosphorus will be on a piece of sandpaper on the outside of the box, and the match must be rubbed on the box to light it.

The word match is in French *mèche*, and is probably from the Latin *myxus*, a lamp wick, something that takes fire easily. Lucifer means light-bringer, and is from the Latin *lux*, light, and *ferre*, to bring.

MAY. See CALENDAR.

MELON, the fruit of a plant of the gourd family, to which the cucumber also belongs. There are in the United States two principal kinds of melons, the muskmelon, so called because it is scented like musk, and the watermelon, named from its watery juice. The muskmelon is supposed to have first come from Southern Asia. Among the best kinds are the citron, cantaloupe, nutmeg, and pineapple. The cantaloupe is named from Cantaluppi, a place near Rome, where it was first cultivated in Europe. The nutmeg is liked best by most people, but the green citron is the principal market muskmelon, and is largely sent from the South to New York and other Northern cities.

The watermelon first came from tropical Africa. Dr. Livingstone found it growing wild there in abundance, and the savages and several kind of wild animals eagerly ate its fruit. The Egyptians cultivated it and pictures of it are to be seen on their monuments. It spread into Asia and Europe, and Europeans carried it to America. Among the best watermelons are the Spanish, Carolina, mountain sweet, orange, and the apple-seeded. They are all raised largely in the South. The citron watermelon is used for making sweetmeats. Its rind or skin is good for making sweet pickles.

The word melon is in Old French

melopepon, from Greek *melopepon*, from *melon* (Latin *malum*), apple, and *pepon*, melon, so called because shaped like an apple.

MENHADEN, a North American fish of the herring family, eight to fourteen inches long, greenish brown on the back, and white below. It is called along our coasts by about thirty different names. In southern Massachusetts and Rhode Island it is named "menhaden," in eastern Connecticut "bony-fish," in western Connecticut "white-fish," and in New York and New Jersey "moss-bunker." In Maine it is known as "pogy," "hard-head," and "hard-head-shad," in Delaware and Chesapeake bays as "alewife" and "greentail," in Virginia as "bugfish," in North Carolina as "fat-back," and further South as "yellow-tail," and "yellow-tailed-shad." Menhaden is the best name, for it is made from its Narragansett Indian name, *munnawhatteaug*, which means "fertilizer," it having been used by the Indians to manure their cornfields, just as it is used to-day. The name moss-bunker, which is Dutch, was given to it because the early settlers of New York thought it looked like the horse mackerel, called in Holland *marsbanker*. Menhaden are taken in nets by the millions along the Atlantic coasts of New England and in Long Island Sound by steam vessels especially fitted for the business. Most of the fish are taken to oil-factories along the coast and tried out for their oil, the refuse being made into guano, but many whole fish are used for manure, one or two being put into each hill of corn or potatoes when planted. The oil is used in leather-dressing, rope-making, and painting. In New Jersey great quantities of young ones are caught and put up in tin boxes the same as sardines, under the names of "American sardines," "shadine," and "ocean trout."

MERCURY, a METAL and one of the ELEMENTS, commonly called quicksilver, because it looks like silver and flows quickly. It is the only metal that is liquid at the common heat of the air. Small drops of pure mercury are sometimes found, but it is usually made from an ore called cinnabar (mercury sulphide), made up of mercury and SULPHUR. The metal is easily got out by heating it in close cast-iron vessels with quick-LIME. The lime takes up the sulphur, and the mercury passes off as a vapor through tubes into a vessel containing water, where it is condensed into liquid mercury. Pure mercury is very heavy, as bright as silver, and is not tarnished by air at the common heat, but when heated it takes up OXYGEN from the air and is turned into a red powder (mercury oxide). By heating this mercury oxide still stronger the oxygen can be driven off again and the mercury turned back to a fluid. Mercury becomes a solid in a great degree of cold (39° to 40° below zero, Fahrenheit).

Mercury is much used for making THERMOMETERS and BAROMETERS, and for getting GOLD and SILVER from their ores. It was once much used for silvering the backs of MIRRORS, but they are made more cheaply with a solution of silver. Mercury unites with most of the other metals to form alloys called AMALGAMS. The principal compounds of mercury are vermilion (mercury sulphide), made up of mercury and sulphur, used as a paint; calomel (mercurous chloride), made up of mercury and CHLORINE, used in medicine; and corrosive sublimate (mercury chloride), also made up of mercury and chlorine, but in different proportions, a deadly poison, used for preserving timber that has to be under water.

Mercury is much used also in making fulminating mercury, the explosive powder put into percussion caps, CARTRIDGES, and fuses. Dry fulminating mercury will explode

violently when struck with a hammer or any other hard thing, but when wet it is non-explosive, so it is always kept wet until wanted for use. It is very useful for exploding gun-cotton, nitro-glycerine, dynamite, etc.

Cinnabar, the ore from which mercury is mostly made, is found chiefly in Spain, Austria, California, Peru, and Russia.

Mercury was named by the old chemists after the heathen god Mercury.

MERCURY, one of the planets of the solar system (see UNIVERSE). It is called an inferior planet, because its orbit or pathway round the sun is inside that of the earth. It is, too, the nearest of any of the planets to the sun; and in consequence cannot be seen by the naked eye except in the west a short time after sunset, and in the east a little before sunrise. We do not know much about Mercury. Some think it turns on its axis once in about 24 hours; but the Italian astronomer Schiaparelli asserts that it revolves only once in its passage around the sun, thus always presenting the same face to the sun, just as the moon does to the earth. He says also that it has an atmosphere, and that he has discovered on it markings much like those on Mars, thought by some to be water courses.

Mercury is smaller than the earth, being only about 3000 miles in diameter; or one-eighteenth its size. It goes round the sun once in 88 days, so its year is only about three months long.

Mercury, one of the planets known to the ancients, was named from the god Mercury.

METALS, ELEMENTS which unite with oxygen and hydrogen to form BASES. When we speak of a metal in this article we mean a pure metal, from which everything else has been separated. The metals which we see every day are not pure, but are mixed with other things.

All metals are alike in some things. They are all opaque, that is, you cannot see through them; and they all have lustre, or a shiny surface, With the exception of gold and copper, their color is a grayish white, with sometimes a bluish or pinkish tinge. In their natural state they are all solids, except MERCURY, which is a liquid; but they differ in hardness; titanium can scarcely be scratched by anything, while SODIUM and POTASSIUM are as soft as wax. Most of them are heavier than water (PLATINUM is more than twenty-one times as heavy), but some are so light that they will float in water (lithium is only about one-half as heavy). All metals can be melted, except arsenic, but some take much more heat to melt them than others.

Metals differ from each other in malleability, ductility, and tenacity. A metal is said to be malleable (Latin, *malleus*, a hammer) when it can be hammered out into thin leaves. GOLD is the most malleable of all metals; next to it come in order SILVER, COPPER, PLATINUM, IRON, TIN, ZINC, and LEAD. Some metals are so brittle that they cannot be hammered at all, and some have to be heated to a certain degree before they become malleable.

A metal is said to be ductile (Latin, *ductilis*, from *ducere*, to draw) when it can be drawn out like wire. Gold is the most ductile of all metals; next to it come in order silver, platinum, iron, copper, zinc, tin, and lead.

A metal is said to have tenacity (Latin, *tenere*, to hold) when it has strength or the power of holding together under a strain. Iron is the most tenacious of all metals; an iron wire will hold up twenty-six times as much weight as a lead wire of the same size. Next to iron in tenacity come the other metals in the following order; copper, platinum, silver, zinc, gold, tin, lead.

Only seven metals were known to the ancients: gold, silver, mercury, copper, lead, tin, and iron, but now between fifty and sixty are known

(see ELEMENT). Bismuth was found out in the fifteenth, zinc in the sixteenth, and arsenic in the seventeenth century; of the rest, ten, including cobalt, platinum, nickel, and manganese, were found out in the last century, and all the rest in his century.

About one-half of all the known metals are very scarce, and some of them have been seen by only a few persons. A few of the metals are found in the native state—that is, pure or unmixed with other minerals—but most of them are generally mixed with oxygen or sulphur.

Compounds of Metals. When mixed with other elements metals form compounds named generally after the element they are mixed with. Thus, compounds with chlorine are called *chlorides*; with bromine, *bromides*; and iodine, *iodides*.

Compounds with oxygen, *oxides*; and with oxygen and hydrogen, *hydroxides*.

Compounds with sulphur, *sulphides*; with sulphur and hydrogen, *hydrosulphides*.

Compounds with nitric acid, *nitrates*; with nitrous acid, *nitrites*.

Compounds with the acids of chlorine, *chlorates*, *chlorites*, etc.

Compounds with sulphuric acid, *sulphates*; with sulphurous acid, *sulphites*.

Compounds with carbonic acid, *carbonates*.

Compounds with phosphoric acid, *phosphates*; with arsenical acid, *arseniates*, etc.

Compounds with silicic acid, *silicates*.

Compounds with boric acid, *borate*.

Many of these compounds are found in nature: thus, the sulphate of calcium, made up of calcium and sulphuric acid, is the common salt called GYPSUM; the oxide of iron, made up of iron and oxygen, is IRON ore; the carbonate of iron, made up of iron and carbonic acid, another form of iron ore, etc.

The word metal is from the Latin *metallum*, Greek *metallon*, a metal.

METAL WORK. Something has been told about the working of metals in the different articles on them, especially in IRON, COPPER, LEAD, TIN, ZINC, and NICKEL, and in those on the ALLOYS, such as BRONZE, BRASS, and PEWTER. In the article STATUE also is told about the making of metal statues, in BELL about the casting of bells, and in the articles on cutlery, such as AXE, CHISEL, KNIFE, SCISSORS, and SCYTHE, is described the way of forging iron. In this article, therefore, we shall tell only about some of the finer kinds of metal work, which we shall divide into three parts—cast metal, wrought metal, and electro-plate.

Cast Metal is any metal melted and poured into moulds, so that when cool it has the shape of the mould. This seems very easy to do, but it is really very hard to do well, especially because some metals, such as gold, silver, copper, and iron, can be cast only in moulds made of sand. The reason of this is, that these metals when melted will not lie close enough in moulds made of anything else to fill up the finer parts, and thus the things cast will not be of the exact shape of the pattern. But when cast in sand moulds these metals will flow into all the smallest parts of the pattern, and thus make a perfect copy of it. The sand is made moist enough to make the grains stick together, and the pattern of the thing to be cast is buried in it in the mould. The mould is made in two parts, so that it can be opened to take out the pattern, which, when the parts of the mould are closed again, leaves in the sand a hollow place of exactly its shape and size. Into this the melted metal is poured, and when cool it forms a casting of the pattern, which only needs smoothing to be finished. The sand mould has to be broken to get the casting out, and a new

one has to be made for each piece. Real bronze, which is mostly copper, can be cast only in sand moulds; but false bronze, which is made of spelter or zinc, can be cast in brass moulds which open like a bullet mould to take out the casting, and which can be used over and over again to make castings. Common mantel ornaments, gas-fixtures, and many other things are cast in this way out of spelter, and varnished to look like real BRONZE. They do not need so much finishing as real bronze, which has to be smoothed and polished, and they are therefore cheaper.

The Japanese make very fine castings in bronze and other metals by making a pattern of the thing to be cast in a kind of vegetable wax, and then covering it over with a mixture of clay, sand, and charcoal dampened with water. Several coats of this are put on, each one being allowed to dry, until the mould is thick enough. It is then heated hot enough to melt the wax, which runs out of a hole made for it, thus leaving a space inside exactly like the pattern, into which the metal is poured. Sometimes, instead of a wax model, they cover the body of an animal, such as a frog, a lizard, or a crab, in the same way, then heat the whole hot enough to burn up the animal, when they blow the ashes out through holes. In this way a perfect copy of the animal is made.

Metal castings are not smooth and finished when they come out of the moulds, like those which we see in stores, but have a good many rough places on them which have to be cut off with chisels and smoothed with files. Sometimes a great deal of labor is needed to finish a piece, especially a statue where much flesh is shown. In this the skin, the hair, and the drapery or clothing have to be worked up in different ways, called "chasing," "matting," etc.

Wrought Metal. Under this head may be put all metal things made by hammering, stamping, punching, rolling, and spinning. In old times much metal working was done by hand by slowly hammering pieces into shape, but now a large part of this kind of work is done by machinery. Tin pans, once made of separate pieces cut out of sheet tin, and soldered together, are now stamped out of one piece by means of heavy DIES worked by steam; and brass kettles and many other things made of brass are stamped out in the same way. The bowls of spoons, too, which were once carefully hammered out by many blows of a hand hammer, are now shaped with a single blow from a heavy drop-hammer.

Silver plate, and the different kinds of metal called britannia ware, queen's ware, white metal, used for making tea-pots, coffee-pots, soup-tureens, cups, and other common things, were once worked into shape by many blows of the hand hammer. The piece of metal was first hammered out flat, and then worked into shape by being hammered over an anvil. The parts of a vase or a tea-pot were thus formed in separate pieces, and then fastened together with SOLDER. But now the metal is rolled out into a sheet between heavy steel rollers, which are screwed closer to each other each time the metal is passed between them. The metal plate or sheet thus made, which is very smooth and of even thickness, is then shaped on a LATHE in a way called "spinning." The plate is fastened between two pieces of wood, one of which, called the "chuck," is of the exact shape of the inside of the vessel to be made. The whole is made to turn round very fast, and the workman, by pressing a tool called a "burnisher," which has a smooth steel head, against the outside of the plate, bends it over and makes it take the shape of the chuck. When it is fitted closely, the lathe is

stopped, and the chuck, which is made up of several pieces, like a hat-block, is taken out. Large pieces like tea-pots, soup-tureens, etc., are usually spun in several pieces and put together with solder; but small pieces, such as cups, are spun out of one piece. Much common ware is now made by stamping in machines, each piece being made in two halves, which are then soldered together. This way is much cheaper, because almost any kind of ornament can thus be stamped on the piece.

The finest way of ornamenting hollow ware is called *repoussé*, a French word meaning "pushed out." This is done by hammering out from the inside metal enough to make the ornaments on the outside. This takes a good deal of time and skill, and is so costly that it can be put only on valuable work, such as fine silver ware. This hammering out makes only lumps on the outside having the general shape of the ornament, which has then to be finished by hand with different kinds of tools. Repoussé work is now imitated so closely by stamping with machines that it is hard to tell it from the real work.

Electro-Plate. In former times silver-plated ware was made out of metal covered with a thin plate of silver. The metal, which was usually copper, had the plate of silver laid on it, and the two were then heated hot and rolled between heavy rollers, which fastened the two tightly together. The tea-pot or other vessel was then made out of this rolled plate. Gold-plated ware was made in the same way. But now all pieces are plated after they are made, in a way called electro-plating, because it is done by electricity.

In the article ELECTRICITY is told about the Voltaic or Galvanic battery, and a picture of one made up of four cups or cells is given on page 267. The ends of the wires connecting the first and the last cell are called the poles of the battery, A being named the positive pole and B the negative pole. When these two poles are joined together a current of electricity is all the time flowing round and round in the way the arrows point in the picture. Soon after the Voltaic battery was first made, it was found out that if the current was made to flow through a metallic SALT, such as nitrate of SILVER, the salt would be separated into its parts, and the metal would fasten itself to the negative pole, while the ACID or other thing with which the metal was mixed would go to the positive pole. Though this was known almost as soon as the battery was found out, it was many years before it was known how to make any good use of it in plating metals; but it is now of great value in the arts, for by means of this principle almost all kinds of plating are done, and many metal things are made which could not be made in any other way.

In silver and gold plating the pieces to be plated, which are usually made of copper, brass, or German silver, because these metals are found to take the plate easiest, are hung in what is called a "bath," a kind of box large enough to hold as much of the liquid to be used as will cover them. For silver and gold plating the liquid is commonly POTASSIUM cyanide, mixed with hot water. The piece to be plated is hung in the liquid by a copper wire which is joined to the negative pole of a battery. If the plating is to be of silver, pieces of that metal are put into the bath near the piece to be plated, and they are joined to the other or positive pole of the battery. The electric circuit is thus made, so that a current of electricity flows round and round through the silver pieces, taking off silver from them and carrying it to the thing to be plated. Just as much metal is put on the thing to be plated as is taken from the pieces of silver. As the

silver sometimes spreads itself unevenly, the thing is kept moving a little, which makes the plate of the same thickness all over. When the plated piece is taken out of the bath the coating of silver looks dull, but it is easily polished bright. Almost all silver-plated articles, such as tea-sets, candlesticks, vases, spoons, forks, thimbles, pencil-cases, and the many other things in common use, are now made in this way.

Gold plating is done in the same way, only pieces of gold are put into the bath instead of pieces of silver. Things made of iron, zinc, tin, PEWTER, and britannia metal are not so easily plated with silver and gold as copper, brass, and German silver; so they are generally first plated with a coating of copper, which is put on in the same way, only a different liquid is used in the bath. The thing thus coated with copper can then be easily plated with silver or gold. Things, too, can be plated with nickel, zinc, and other metals; and even ALLOYS, such as bronze and brass, can be used for plating on copper, or metals can be plated on alloys.

Metals can also be plated on things which are not metals. For instance, plaster or clay statues can be covered with a metal; and cloth, lace, flowers, plants, and insects may thus be coated with gold, silver, copper, zinc, etc. Even a spider's web has been plated with gold and silver. In this way, too, copies of costly pieces of metal work, such as vases of gold and silver, may be easily made. This is done by making a mould of the outside of the vase or other piece in wax, gutta-percha, sulphur, or some other substance, in two parts, which are afterward put together. The inside of the mould is then covered with a thin coat of BLACK LEAD, which is a good conductor of electricity. The mould is then put into the bath, where it soon becomes coated all over the inside with a thin plate of copper, which is an exact copy of the vase. This is then plated in a silver or gold bath just like any other article, and when polished can scarcely be told from the one from which it was made.

Electrotype plates, used in printing books, are made in the same way. A wax mould is made from each page of type or engravings. This is then covered with a very thin coating of black lead and put into the bath, where in two or three hours a coating of copper is formed on all parts of the mould where the black lead is. This coating, which is called a "shell," is about as thick as common letter paper, and is a perfect copy of the page of type. It is usually made stronger by pouring melted type metal into the back, which makes the plate about an eighth of an inch thick. When used this is generally tacked on to a piece of board thick enough to make the plate just as high as a common type (see PRINTING).

METEOR. See AEROLITE.

MEXICAN ONYX is not a real onyx, but a lime (carbonate of CALCIUM) mixed with a little oxide of iron, oxide of manganese, and carbonic and sulphuric acids. It is sometimes called Mexican marble. The Mexican Indians call it "tecali," a corruption of the Aztec word *teocali* (Lord's Mansion), because this stone, considered sacred, was used chiefly for the ornamentation of temples, and the making of sacrificial vessels and idols. Cortez and his followers admired it greatly and, like the Aztecs, devoted it to religious uses, such as the making of altars and baptismal fonts, and some of the finest specimens of it are still to be seen in the churches of Mexico and Puebla.

The principal quarries are in the State of Puebla, where it is found sometimes in the form of bowlders, or separate masses, from a few inches in size up to twelve cubic feet, and sometimes in veins encased in other rock. Some of it is white or yellowish, and some beautifully variegated with green, brown, red, and yellow

shades. Sometimes thin slabs without color are painted to counterfeit the more beautiful kinds, and covered with a coating of transparent cement so skilfully as to deceive all but experts. The Indians carve the stone into crosses, crucifixes, reliquaries, inkstands, paper weights, and other small objects, to sell to travellers; and much of it is sent to the United States and to Europe for the decoration of costly houses, and for making panels, mantel-pieces, table tops, clock cases, etc.

A very beautiful kind of onyx, said to be superior to Mexican onyx, is found in New Mexico, where it is quarried in large blocks. It comes in several colors, dark green and cream and pink and salmon mixed, some striped and some mottled. It is easily carved and takes a high polish. The New Mexico building at the Columbian Exhibition at Chicago was built of it.

MICA, a kind of mineral made up of several different things, and found in little shining scales in granite and some other rocks. It is commonly called isinglass. It is sometimes found in quite large pieces, which split up into thin plates, having a pearly shine, and which are so transparent that they can be used instead of glass in windows and lanterns. It is also used in the doors of stoves. The largest sheets of mica are found in Siberia and in Sweden, but some very large pieces have been found in this country in New Hampshire and North Carolina.

The word mica is from the Latin *micare*, to shine.

MICROSCOPE, an instrument to aid us in seeing things which are too small to be seen well with the naked eye. When we try to look at anything which is very small, the image which the rays of LIGHT from it make in the eye is too small to be clearly seen; and if we bring the thing close to the eye the rays of light from it will be so scattered that he image will be blurred, that is, not clear. But if we put a convex LENS between the eye and the thing to be looked at we shall be able to bring it much nearer, and the rays will be so bent to a point that the eye can take them in all at once, and the thing will appear larger and plainer. A LENS thus used is called a magnifying glass (from Latin *magnus*, large), because the thing looked at is magnified or made larger by it. When a magnifying glass is fitted into a tube so that in looking through it you look through the tube also, it is called a simple microscope. The compound microscope is made up of two convex lenses in a tube, one of which is called the object glass, and the other one the eye glass. The thing looked at is first magnified by the object glass, and this enlarged image is again magnified by the eye glass.

The microscope is one of the most wonderful and interesting of instruments, for by its means we have been able to find out not only how a great many things are made, but also that there are in the world a great number of living things which we did not know about before. It has shown us that every drop of water, every leaf, and indeed almost every particle of animal and vegetable matter, is filled with multitudes of little creatures so small that they cannot be seen with the naked eye, but which are as wonderfully made as ourselves (see ANIMALCULE).

The word microscope is from the Greek *mikros*, small, and *skopein*, to see.

MILE, a measure of distance, equal to 8 furlongs, 320 rods, 1760 yards, or 5280 feet. This mile, called the statute mile, because it was defined by a statute passed in Queen Elizabeth's time, is in use in England and the United States; but the mile of other countries differs much from it. Thus, the German short mile is equal to nearly four (3.897) English miles, and the German long mile to five and three-quarter (5.753)

English miles. The Danish mile equals 4.684, the Swiss 5.201, and the Swedish 6.648 miles. There are 69.16 statute miles to a degree of the equator. A square mile equals 640 acres.

A **Geographical Mile** is equal to one-sixtieth part of a degree of the equator, and is therefore 6080 feet or 1.1527 statute mile. The geographical mile is the same as a nautical mile, called by sailors a knot, and is used by mariners of all nations; but the Germans make the geographical mile one-fifteenth of a degree of the equator, or four nautical miles.

The word mile is Anglo-Saxon *mil*, from the Latin *mille*, a thousand that is—a thousand paces (*millia passuum*).

MILK. To the naked eye milk looks like a white liquid not at all transparent; but if we examine it with a microscope we shall see that it is really a bluish transparent liquid filled with round floating balls of fat, each one enclosed in a separate film or thin skin of ALBUMEN. These little balls are so small that if you put ten thousand of them in a row they would not measure more than one inch. When milk is set away in pans in a cool place for a few hours, these balls of fat rise to the top by thousands and form the rich yellow crust called cream. By churning cream the cases of the balls are broken, and the fat runs together and makes BUTTER. After the cream has been taken off of milk, what remains is called skim-milk. Skim-milk is made up of curd or caseine (Latin *caseus*, cheese), from which CHEESE is made, and of whey, a thin watery liquid, in which the caseine is dissolved. Milk contains sugar also, and when it is kept too long this sugar causes it to ferment (see BEER), or work, which forms lactic ACID and turns the milk sour. The lactic acid mixes with the caseine, which in sweet milk is like the white of raw egg, and coagulates it or makes it thick like the white of egg boiled. This is commonly called curdling (see CHEESE).

Milk is given by the females of all MAMMALS. All kinds of milk are made up of the same things, but in different quantities. Cow's milk has more fat and caseine in it and less sugar than human milk. In foreign countries the milk of the goat, sheep, ass, mare, and bison are much used; but none is so good as cow's milk. In the United States is made much condensed milk, which will keep sweet for a long time, and is very useful to carry on sea voyages. It is only cow's milk boiled down until the water is out of it, and then sweetened with a little sugar, thus making a thick sweet paste which is sealed up in tin cans. Large AIR-PUMPS are used to pump the air out of the covered pans in which it is boiled, and in this way it is thickened very quickly.

The word milk is from the Anglo-Saxon *meolc*, milk.

MILKWEED, the common name of a family of plants, so called because they are full of milky juice. All the milkweeds belong in North and South America, though some are now cultivated in Europe as ornamental plants. The seeds are covered with a beautiful silky down, which has been mixed with cotton and made into cloth, but the threads are weak. In the Southern States the common milkweed is called Virginia silk. Its root is used in medicine.

MILLET, the name of several kinds of grasses, the seeds of which are used for food. The grains are very small, but the number on each stalk is so great as to make it worth raising in countries where Indian corn and other grains do not grow well. In Africa, India, and in some parts of Europe it is much raised for food, both for men and cattle. The seeds are ground up into meal for bread, and a kind of beer is also made from them.

The word millet is from the Anglo-Saxon *mil*, Latin *milium*, millet.

MINK, a small animal valued for its fur, found in the cold parts of North America, Europe, and Asia. The common American mink, which looks much like a weasel, is twelve to eighteen inches long, and has a bushy tail half as long again. Its color is dark brown, though some are yellowish-brown, and its tail is nearly black. It lives in burrows dug in the banks of rivers and ponds, feeds on small birds, frogs, crawfish, and other fish, and will often steal chickens at night, at which time it is most active. The fur of the mink is sometimes called American sable, and it is used for making muffs, tippets, etc.

The mink is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family, which includes also the common WEASEL, the ERMINE, SABLE, MARTEN, FERRET, POLECAT, SKUNK, and OTTER.

MINNOW, the common name of many kinds of little fishes found in brooks in all parts of the United States. Some of them are really DACE. They are used mostly for bait to catch other fish.

The word minnow is probably from the French *menu*, small, Latin *minutus*, minute, little.

MINT, a sweet-smelling plant. There are many kinds of mint, the most useful of which are spearmint and peppermint. Spearmint, which is the common mint found in gardens, was brought to this country from Europe, but is now found almost everywhere in the United States. Its leaves are used in making mint sauce for roast lamb, and for flavoring soups and various drinks. The oil of mint is distilled (see ALCOHOL) from them; and from the oil is made the essence of mint and mint water. Peppermint is grown in the United States chiefly in Wayne County, New York, and St. Joseph's County, Michigan, where large farms are devoted to raising it. It is used principally for making oil of peppermint, for flavoring confectionery, and making cordials and essences. Essence of peppermint is made by mixing the oil with alcohol. It is much used in medicine.

Mint is in Anglo-Saxon *minte*, from Latin *menta*, Greek *mintha*, mint.

MIRROR, a looking-glass. The manufacture of plate glass for mirrors is described in the article GLASS. A few years ago almost all glass mirrors were made by coating the back with a white metal commonly called silver, but which was really an AMALGAM of MERCURY and tin-FOIL. A sheet of tin-foil was spread out smooth on an iron or stone table, and mercury poured over it until about a quarter of an inch deep, it being kept from running off by strips of glass on three sides of the table. The plate of glass, carefully cleaned, was slid on flat from the open side, to keep out air bubbles; and the table was then tipped so that the mercury not needed would run off, and heavy weights were put upon the glass. After standing thus a few hours the glass, to which the amalgam had become fastened, was taken up and set aside for several weeks to dry. Mirrors made in this way are the best and most lasting, but most mirrors are now made by spraying the back of the glass with a solution of pure silver. This is then painted over with a brown or other dark-colored paint which dries at once, so that the mirrors are ready for use the next day.

It is not known exactly when mirrors were first made of glass. The Venetians coated them with mercury and tin more than three hundred years ago, and mirrors coated with lead are mentioned about six hundred years ago. The mirrors of the ancients were made mostly of polished metals, especially of bronze. They were usually small and round, and were fitted with a handle handsomely carved and ornamented. Many

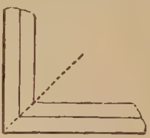
such hand mirrors have been found in Egyptian tombs. The Romans used silver mirrors, and at a later time, mirrors made of a black stone called obsidian, polished very highly, and set into walls as panels.

The Japanese still use small metal mirrors, much like those of the ancients, and in their country the bronze mirror with its stand is sometimes the only furniture in a room. The Japanese say that the sun goddess, who had control of sunlight, once became so angry with her brother that she shut herself in a cave, and left the outer world in darkness. At last a man made a bronze mirror with a highly polished surface, and all the people rejoiced so loudly that the sun goddess peeped out to see what was going on. She was told that they had found a goddess more beautiful than herself, and when jealousy caused her to try to see the new object of admiration, the people held the mirror before her eyes and she beheld the reflection of her own face. The compliment pleased her and she came out and favored Japan once more with sunlight.

When she sent her adopted grandson (who was the great-grandfather of the first emperor of Japan) to conquer the world, she gave him three things: a precious stone, emblem of the spirit of woman; a sword, emblem of the spirit of man; and a mirror, emblem of her own soul. "Look," she said, "on this mirror as my spirit; keep it in the same house and on the same floor with yourself, and worship it as if you were worshipping me." And ever since that time the Japanese have held it sacred, looking upon it in much the same way as Christians regard the cross. Women keep it as their most valuable possession, and every bride is presented with two mirrors.

The word mirror is from the French *miroir* which is from the Latin *mirari*, to admire.

MITRE, the joint made by the ends of two pieces fitted together at a right angle, as shown in the picture. The joints in the corners of a picture frame are mitre joints. They are usually sawn in a long box called a mitre-box, the sides of which have saw cuts through them at the right slant to guide the saw in cutting.



Mitre Joint.

Moa.

MOA, the name given by the natives to a gigantic bird that used to live in New Zealand. It is called

dinornis by naturalists. It was somewhat like the ostrich, but taller, having been, when full grown, ten to fifteen feet high. It had long, stout legs and feet with but three toes, which made tracks 22 inches long and 6 inches wide. Many bones of the moa and some of its eggs, much larger than ostrich eggs, have been dug up in New Zealand. It is supposed to have become extinct in quite recent times.

MOCKING-BIRD. The mocking-bird is found only in North and South America and the West Indies. It is plentiful in the warm parts of the United States, but is seldom seen in the Northern States. Its form is graceful, but its plumage is not very handsome. The general color above is ashy brown, and the under parts are white with a brownish tinge; the legs and bill are black, and the wings and tail nearly black. But although rather homely in looks, it is one of the gayest and sprightliest of birds, and one of the best singers in the world. Its own song is very sweet and pleasing, and it will sing the notes of other birds so perfectly that one can scarcely tell the difference between them. It will also whistle tunes, and imitate the bark of a dog, the crow of a cock, the sound of a saw, the creak of a wheel, and other sound; but it cannot speak words like the parrot. It takes great delight in singing the songs of other birds, passing from one to another with the greatest ease, now warbling like a canary or bluebird, then cackling like a hen, or screaming like a swallow. Sportsman are often deceived by hearing it cluck like the partridge or whistle like the quail, and other birds are frightened at hearing what sounds like the scream of a hawk, but which is in reality only a little mocking-bird scarcely larger than themselves. Like the nightingale the mocking-bird often sings at night, beginning its song when the moon rises. The Mexicans call it the "bird of four hundred tongues."

The mocking-bird loves to build its nest in gardens near houses, but it does not like to have anyone come too near to it, and it will attack with great fierceness the face and hands of boys who try to rob it. The black snake, which is a great enemy of birds, is often driven away from their nest by mocking-birds, who dart at its eyes with their spearlike beaks. The eggs, which are usually five, are pale green with brown patches and spots. Two or three broods are raised each year.

Mocking-birds are easily tamed and live very happily in cages, if they are caught when young. They should be taken from the nest when eight or ten days old, and fed for a few days on a little raw meat chopped fine and soaked in milk. Afterward they may be given thickened meal and water, or meal and milk, mixed now and then with minced raw meat. Both young and old need some kind of berries, such as strawberries, huckleberries, or almost any kind of wild fruit. Gravel should be kept in the cage, and grasshoppers, beetles, or other insects should be given to them now and then. The mocking-bird makes a very familiar and affectionate pet, and is long-lived.

The mocking-bird belongs to the order *insessores*, or perching BIRDS, and to the thrush family, in which are also the American ROBIN, and the CAT-BIRD.

The mocking-bird gets its name from its habit of mocking the songs of other birds.

MOLASSES. See SUGAR.

MOLE. The mole is found in Europe, Asia, Africa, and North America, but not in South America. The kinds are somewhat different in each country, but their habits are much the same.

The **European Mole** is five or six inches long, with short feet armed with claws, and a sharp hog-like nose. It is usually dark brown or black, and its short hairs grow

straight out from the skin, so that its fur keeps smooth whether it moves forward or backward in its underground burrows, and does not hold dirt. Its senses of hearing and smell are very sharp. Its eyes, which are very small, are protected by rough hairs that cover them and keep out the dirt when it is under ground; but when it comes to the light it uncovers them and then sees very well. Its food is chiefly earthworms and grubs, which it pursues underground, throwing up the earth in little ridges called mole-hills. The house of the mole

House of the Mole.

is very curious, and is always made in the same way. It is formed, as shown in the picture, of a little mound of earth in which are two circular galleries, one above the other, and connected by five passages. In the middle of the lower gallery is a round place where the mole makes its nest, in which it sleeps. This is joined with the upper gallery by three passages, but not at all with the lower one. Nine or ten other passages run in different directions from the lower gallery, and into one of these opens a passage leading downward from the bottom of the nest.

The **Shrew Mole,** or common mole of the United States, is not quite so large as the European mole, and is of a dark lead color, with white feet and tail. It lives usually near streams or in damp places.

The **Star-nosed Mole,** of the northern parts of North America, is so called because the end of its nose is surrounded by little fleshy points, making it look like a star. These points are used as feelers.

The mole is a MAMMAL of the order *insectivora*, or insect-eating animals.

The word mole is shortened from the Old English *mold-warp*, which is from the Anglo-Saxon *molde*, mould or earth, and *weorpen*, to throw up.

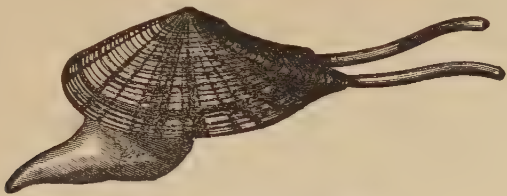
MOLLUSKS. The general nature of mollusks, which are soft-bodied animals, without any skeleton either inside or outside, is told about under ANIMAL. They are divided into two classes: I. **Acephalous Mollusks,** or those without a head; and II. **Cephalous Mollusks,** or those with a head.

I. **Acephalous Mollusks** are divided into two groups; those with shells and those without shells. There are many of those without shells in the sea, usually found sticking in seaweed or to rocks, but we have not space to tell about them. Almost all the mollusks of this class which have shells are bivalves, that is, their shells are made up of two valves or parts, like the shells of oysters and clams. Among the principal bivalves are the OYSTER, the CLAM, the MUSSEL, the SCALLOP, and the SHIP-WORM. Most bivalves live in one place, fastened to rocks and other things at the bottom of the sea, but some can change their places by means of a fleshy kind of tongue, called a foot. The animal runs this out of its shell, as shown in the picture, fastens it to something by the point, and then by drawing it in pulls itself along. The two long things stretched out on the right are feelers.

The razor shell, a bivalve mollusk, which gets its name from its shape, bores into the sand with its foot. It can make this foot long and pointed like a dagger, so that it is easily thrust down into the sand. As soon as it is in, it swells out at the end like the clapper of a bell, which gives it a hold on the sand, and then by shortening its foot it draws its whole shell in quite fast. It can thus bury itself in a little while fifteen or twenty

inches deep. Some other mollusks use their foot to push themselves along, and others give little leaps by bending it up under them and then straightening it out.

Another family of mollusks bore out for themselves houses in solid rock. These houses are usually wide at the bottom, with long narrow necks, as shown in the picture, the mollusk scooping it out more and more as it grows larger. In this hole the pholas, as it is called, lives, breathing through its long tube, which it



Bivalve Mollusk, with Foot out.

runs up to the mouth of the hole. For a long time it was not known how the pholas bored its hole, but we now know that it is done by the sharp edges of its shells, which are harder than the rock they cut. Sometimes the holes of boring mollusks are

A Pholas in a Piece of Stone.

found in rocks far above the sea, and by this we know that the land in which they lie must once have been under the sea. At a place called Pozzuoli, on the Bay of Naples, are the ruins of the ancient temple of Jupiter Serapis, the pillars of which are full of holes made by mollusks. We know, therefore, that this temple must have been sunk in the sea at some time, long enough for the borers to do their work, and afterward raised up again.

Some bivalves spin a kind of silk from their foot, by which they anchor themselves to the rocks. This silk is made in much the same way as the web of the spider and the caterpillar. There is a little bag at the end of the foot which gives out a fluid which thickens so that it may be drawn out into a fine thread.

Many threads are thus spun until a bunch or beard is formed, by which the animal can anchor itself so tightly to a rock that it cannot be pulled off without breaking it. Some of them fasten together with these threads stones, pieces of coral, and other hard things so as to surround their shells with a kind of defence, behind which they can lie in safety.

A kind of mussel called the pinna, found in the Mediterranean, has a beard so long and silky that its threads can be spun and woven. In Sicily a kind of soft cloth is sometimes made of it, and in Taranto, Italy, they mix it with about a third of real silk and make gloves and stockings of it.

II. **Cephalous Mollusks** are divided into three groups; 1. Cephal-

opods, or head-footed ones, in which the feet grow out around the head; 2. Pteropods, or wing-footed ones, which have a pair of winglike fins, by which they can swim fast; 3. Gasteropods, or belly-footed ones, which have a single broad foot under the body.

1. The cephalopods have a flabby body and a large head, with two great staring eyes, one on each side; and a mouth, or rather beak, bent like the bill of a parrot, around which branch out eight or ten arms or feet. When they walk these arms are used as feet. They can run very fast on the beach with these feet. They can also move backward in the water by squirting water out of a kind of funnel placed under the head. Cephalopods are found in the waters of all the oceans; some living in deep water and some along the coasts. They live on fish, shellfish, and other sea animals. As they cannot move very fast, they lie in ambush behind rocks or in holes, with their long arms ready and their eyes wide open, waiting for their prey. As soon as any animal comes within reach, it is seized, drawn in, and eaten. Their arms are furnished with suckers, which cling tightly to whatever they grasp, so that even slimy fish are held fast. They have also a kind of bag filled with an inky fluid, which they can squeeze into the water on the coming of danger, and by thus darkening it hide their movements. Cephalopods are mostly

Cuttle-Fish Eggs.

night animals, and usually hide away during the day.

Among the cephalopods are some with ten arms or legs, and some with eight. The principal ten-legged ones are the CUTTLE-FISH and the squid. In the Pacific Ocean is a kind of cuttle-fish which can make very high leaps. They sometimes jump out of the water on to the deck of a vessel, and some have been seen to jump clear over a vessel. Cuttle-fish lay their eggs in the spring, and take great care of them, always fastening them to something in the water, where they are hatched out by the heat in about a month. The strong stem of some seaweed is generally chosen for this. The eggs, which are quince-shaped, have a black jellylike string by which they are wound round the stem, as shown in the picture. Twenty or thirty of these eggs are generally hung together in a cluster like a bunch of grapes, from which they are sometimes called sea-grapes.

The squid is much like the cuttle-fish in looks. The common squid, found on the coast of New England, is six to twelve inches long, but very large ones have been found off the coast of Newfoundland. In 1872 one was seen whose body was nearly twice as long as a man, while its arms were five times as long as a man. It is thought that some of them grow to be at least fifty feet long.

Squids make a large part of the

food of whales, dolphins, and porpoises, and small ones are cut up for bait for cod-fish. In ancient times they were eaten by the Greeks and Romans, and they are now eaten by the modern Greeks during the long fasts of their church, when they are forbidden to eat either flesh or fish. The Chinese and the Indians of the Pacific also eat them.

Squids or calmars, as they are sometimes called, are found on the coast of Norway, and they probably gave rise to the stories of the great sea animal called by the old writers the kraken, which was said to be a mile long and to look like an island when it was on the surface of the water. An old book gives a picture of a kraken drawing down into the sea a three-masted ship, around which it has wrapped its long arms: and a story is told of a bishop who set up an altar and said mass on the back of a kraken lying on the shore, which he mistook for a rock. The great monster lay still until the service was done, and then ran into the sea, to the terror of all present.

The principal eight-armed cephalopods are the octopus, or poulpe, and the argonaut. The common octopus, found in the European seas, has a round body about as large as a man's fist, with eight arms around it, each three or four feet long. Near the body these arms are joined by a tough skin, as shown in the picture, by opening and shutting which it can swim backward. It has also a tube which opens near its mouth, through which it blows out water, which helps it to swim in other ways.

Octopus.

It can walk on its eight arms in the same way with the cuttle-fish. In the seas of hot countries the octopus grows very large. Such ones are very strong and dangerous. The "devil fish," told about by Victor Hugo in his book called "The Toilers of the Sea," which catches a man and draws him down into his cave, is something like an octopus, but there is really no such animal in the world as the one he describes.

The argonaut is more commonly called the nautilus. The ancients used to tell wonderful stories about this animal, and saw in its pretty shell the model of a ship, from which the Greeks made its name of nautilus, *naus* being the Greek word for ship. Pliny, the Roman writer, says it raises up its two first arms with a thin skin stretched between them for a sail, and rows and steers with its

other arms. But it is now known that it moves like other cephalopods, by spouting water out through a tube. When it swims on the surface of the sea, all its eight arms are stretched out, as shown in the picture. When frightened by anything, it draws itself into its shell, as in the next picture, and sinks to the bottom. Only the female argonaut has a shell, the male being naked and only about a tenth as large. The female lays its eggs in the shell, and the little ones are hatched in this floating cradle. In the paper nautilus the shell is as thin as paper, but in the pearly nautilus it is thicker and covered with fine mother-of-pearl, which is much used for ornamenting furniture. In China and other Eastern countries vases and drinking cups are made of pearl nautilus shells, which are handsomely carved.

2. Pteropods, or wing-footed mol-

Argonaut Swimming.

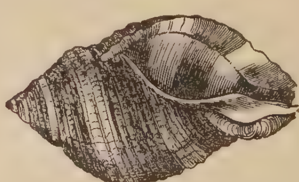
lusks, live in the open sea, seldom coming near the land, and are the principal food of whales and sea birds. We have not space to tell about them.

3. Gasteropods, or belly-footed mollusks, are mostly those animals which live in a single shell, that is, a shell made up of only one part, which is called, therefore, a univalve.

Most of them are found in the sea, but some live in fresh water,

Argonaut in its Shell.

and some on the land. The SNAIL is a land gasteropod. From the sea gasteropods come the beautiful SHELLS which we see in museums, or which are used for ornaments in houses, gardens, and grottoes. All these shells were once the homes of living animals, each of whom moved round on the bottom of the sea by means of its single foot. From one of these animals came the purple dye of the ancients, so celebrated as Tyrian purple. This dye, which was used only for coloring the mantles of princes and nobles, was a beautiful deep violet, with sometimes a reddish shade. It was made from the juice of a mollusk which lived in a little spiral or twisted shell, shown in the picture, found along the Mediterranean coast. Near the ruins of the ancient city of Tyre are



Tyrian Purple Mollusk.

still to be seen hollow places in rocks, in which were found broken shells, as if they had been pounded there by the ancient dyers.

The word mollusk is from the Latin *mollusca*, which comes from *mollis*, soft. Cephalous is from the Greek *kephale*, head. Cephalopod is from *kephale*, head, and *pous*, genitive *podos*, foot; pteropod from

pteron, wing, and *pous;* and gasteropod from *gaster*, belly, and *pous*.

MONEY. Almost every kind of thing which can be exchanged for goods, merchandise, or other necessary articles has been used at some time for money. In ancient Greece iron or copper nails were thus used, and the Spartans coined money out of iron. Cattle were used as money in both Greece and Rome, and from this came the Roman name for money, *pecunia*, from, *pecus*, cattle, from which we get our word "pecuniary." All the metals, even lead, tin, and platinum, have been coined into money. The Carthaginians had leather money; it was used, too, at the siege of Leyden in 1574, and about the same time pasteboard money was made in Holland. The Chinese had paper money in the thirteenth century, and the skins of wild animals passed for money among the ancient Russians. In China pieces of silk pass for money; in some parts of India cakes of tea, in Abyssinia salt, in Iceland codfish, on the coast of Africa cowrie shells, and in the middle parts of South America soap, chocolate, cocoanuts, and other things. Cowrie shells were largely used, too, in India and in the South Sea islands. In old times vessels going to Africa after cargoes of ivory, palm oil, sandal wood, etc., used to go first to Zanzibar, or other ports where cowries could be bought, to get a cargo of them to trade with the natives.

The American Indians used many different things: coal, bone, shells, mica, mother-of-pearl, agate, jasper, carnelian, gold, silver, copper, lead, and iron, money made out of all these having been found in their graves in the West. The New England Indians, especially the Narragansetts of Rhode Island, made great quantities of shell-money which they called *wampum* or *wampum-peage*. (Indian *wampum*, white, and *peague*, strung beads); they had two kinds, both of the same size and shape, one of which was white and the other purplish or brownish black. The white was made from the PERIWINKLE or conch shell, the black, worth twice as much as the white, from the shell of the quahaug or round clam. In each valve of the shells of this clam is a purplish black spot, called by fishermen the "eye," marking the place where the muscle that held the two valves together was fastened to the shell. This blackish part was carefully broken out, ground round by rubbing on stones, and then drilled through with a stone awl so that it could be strung on a deer sinew or other string. White wampum was easier made, as the hollow of the periwinkle made natural beads which did not have to be drilled.

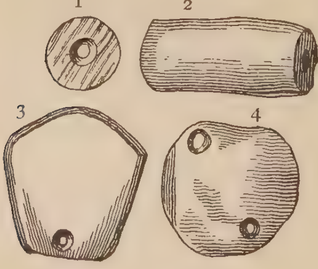
Wampum was used by all the Indians east of the Mississippi as money for buying and selling. They sold for it anything they had, skins, furs, their lands, their slaves, and sometimes their children. Powhatan is said to have sold Pocahontas for a bushel of Roanoke, a cheaper kind of wampum made in Virginia of oyster shells. The Delaware Indians had a treasury where they kept a supply of wampum to pay the expenses of the tribe. At their feasts they used to throw handfuls of it on the ground to be scrambled for by the children. The English settlers learned from the Indians the use of wampum, and it became the money of the early colonies. It was usually strung on strings and woven into bands as broad as the hand and six feet long, called wampum belts, or a fathom of wampum. The whites soon began to make it themselves, and as they had iron tools they could do it much faster than the Indians; but they did not smooth the edges so carefully, and their wampum was not so valuable. Washington Irving, in his "Knickerbocker's History of New York," gives an amusing account of the troubles which were brought upon New

Amsterdam by the Yankees, who coined oyster shells into wampum and bought up all the goods with this cheap money. The Indians used wampum belts for ornaments also, though glass beads were worn more generally at a later date.

The Indians of the Pacific coast also made shell money, but it was

California Wampum Shells.

different from that used on the Atlantic border. They manufactured it from several different kinds of shells and stones, and in different shapes and colors, though most of them are like beads or buttons. Several forms are shown in the picture. The *hawok*, the cheapest kind, was a disk of white shell with a hole through it by which it was strung, as in Fig. 1. Fig. 2 is another shape, not so common. The *ullo*, made from



California Indians' Money.

the shell of the red abalone, was cut into pieces shaped like a keystone or a disk, as in Figs. 3 and 4, and sometimes with one and sometimes with with two holes. Those with two holes were fastened together and worn as necklaces and head-dresses, or used to ornament baskets. When dances were given the Indian squaws used to wear all the money they could get, and old Indians in the West still hoard shell money for their wives to display at feasts, or to offer on the funeral pyre of some great chief. See BANK-NOTE, COIN.

The word money is from the Latin *moneta*, a mint, so called from the temple of Juno Moneta (the adviser, from *monere*, to advise), at Rome, where money was coined.

MONKEY. Monkeys are found in the hot parts of America, in Asia, and in Africa. APES and BABOONS are kinds of monkeys, but apes have no tails and baboons have only short tails, while monkeys have very long tails. Monkeys are more like man than any other animals, both in their outward form and in their skeletons, and they sometimes act much like man; but when wild they seldom walk upright, preferring to go usually on all fours. They live mostly in trees, up which they climb with great ease, and delight in leaping from branch to branch, or in twisting their tail round a limb and swinging by it until they can seize hold of another one. Their food is mostly fruits, nuts, and insects. They are very cunning and mischievous, and may be taught many funny tricks.

New World Monkeys. The monkeys in America are unlike those of the Old World, having broad noses, while those of the Old World have narrow noses, with the nostrils close together. In the forests of Brazil and Guiana are great troops of monkeys called howlers, which make a frightful noise during the night. As many as thirty or forty may sometimes be seen in one tree. On the banks of the Amazon and the Orinoco are often seen troops of little black monkeys (coaitas), commonly called spider monkeys, because they look like black spiders as they swing by their tails among the branches of the

trees. The black saki is a little larger than the spider monkey, but has nearly the same habits. Its face is more like a man's than that of any other American monkey. The eyes are large, its chin is covered with a thick beard, and it is said to drink out of the hollow of its hand so as not to wet its beard. There are also several kinds of monkeys in Brazil called marmosets, which live on fruits, eggs, small birds, and insects. The silky marmoset has silky golden yellow fur, which forms a kind of mane on the neck. The leonine (Latin *leo*, lion) marmoset is brown with a black face, and has a brown mane, which stands up when it is angry, like that of a lion. It is the smallest of all monkeys. The striated marmoset is gray, and has a long, beautiful tail, marked with brown or gray rings. It is easily tamed, and makes a very interesting pet.

Old World Monkeys. Among the monkeys of the Old World is the entellus, found in India, which kills snakes. When it sees a snake asleep, it creeps up on all fours, seizes it by the neck and knocks its head against a stone until it is dead. It then gives the snake to the young monkeys, who play with it just as kittens do with a mouse. The Hindoos make a god of it, build temples and hospitals for it, and believe that whoever kills one will die within the year. These monkeys go into houses and steal things to eat, but their visits are thought to be a great honor. The proboscis monkey has a nose about four inches long. It lives in great troops in the woods in the island of Borneo. In Africa is found the green monkey, which is olive-green on its back and whitish below with a black face. It is lively and playful when tamed. Another African monkey has a brownish body, with blackish legs and tail, yellowish green on top of the head, and bright yellow on the cheeks. It is very cunning and playful.

Monkeys may be taught a great many amusing tricks, and in some large cities in Europe are theatres where monkeys act much like men and women. In almost all circuses, too, there are usually trained monkeys which ride horses, jump through hoops and over bars, and do many other bright things. More than two hundred years ago trained moneys were shown at fairs and other public places in England, so that they are by no means a new thing.

Tame monkeys make amusing pets, but they are often very troublesome, as they love to imitate their masters in everything they do. A monkey once cut his throat in trying to shave as he had seen his master shave himself. Monkeys do not like to be cheated, and will fly into a rage if any trick is played upon them. A lady once brought a bright little monkey with her from India. He was a great pet on board the ship, and used to take much delight in having a frolic with his mistress. But one day she carried a looking-glass on deck and called Jocko to come and look in it. He was much pleased when he saw his form in it, and jabbered at it and made faces at it in the most excited manner, for he supposed it was another monkey; but when he put his paw around to feel the back of it, he found that there was no other monkey there. He thought his mistress had tried to cheat him; he flew into a terrible passion, and she had to run to save herself from a scratching. He never forgot it, and she could never again make friends with him.

Everybody has heard the story of the monkey that used the cat's paw to draw the hot chestnuts from the fire, but this is beaten by a monkey story which comes from South Africa. The monkeys trouble the coffee planters there very much by running over their fields in search of the fruit of a shrub which grows among the coffee plants, and which they love very much. On one of those coffee plantations some wasps

had built their nests among these shrubs, and though the monkeys had often been seen looking eagerly at the fruit, none of them had ever dared touch it for fear of being stung. One morning the planter heard terrible cries, and turning his spy-glass toward the place saw a curious sight. A fat old monkey was catching the young ones and throwing them one by one into the bushes. The shock brought down the wasps' nests, and the wasps flew upon and stung the young ones, who were crying and groaning with pain while the old rogue quietly ate the fruit.

The monkey is a MAMMAL of the order *quadrumana*, or four-handed animals.

The word monkey is supposed to be from the Old Italian *monicchio*, a monkey, which is from *monna*, an old woman; so the animal is so called because it looks like an old woman.

MONTH. See CALENDAR.

MOON. In the article UNIVERSE it is told that several of the planets, including the Earth, Mars, Jupiter, Saturn, Uranus, and Neptune, have one or more satellites, or moons, which are all the time rolling round them while they roll round the SUN. The moon which attends our earth is, next after the sun, the most interesting of all the heavenly bodies, because she is nearer to us than any other. She looks to be about as large as the sun, but she is really many million times smaller, and looks as large only because she is so much nearer, being only about a quarter of a million miles away (238,-818 miles).

The moon rolls round the earth in a little less than a month, or about thirteen times every year. Though she sheds light on the earth, she does not give any herself, but only reflects on us a part of the light of the sun, which shines on her as she moves in her orbit (see UNIVERSE). The earth does the same for the moon. If you could stand on the moon, you would see the earth hanging like a balloon in the heavens, and shining with a silvery light, just as the moon looks to us at night. It would be sometimes crescent-shaped and sometimes round, just as the moon is, but it would be about thirteen times as large as the moon.

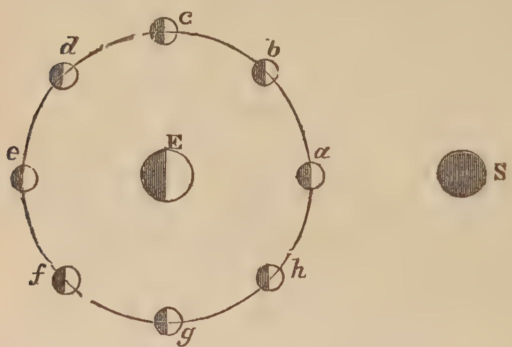


Fig. 1.—Different Positions of the Moon.

The reason why we do not see all the moon, but only a part of it, much of the time, is shown in the picture. In this E is the earth, *a b c d e f g h* the moon in different positions, and S the sun. When the moon is at *a* we cannot see any part of it, because it is between the earth and the sun, and the sun shines only on the side of the moon which is toward itself. When the moon moves toward *b* we begin to see it, at first like a little sickle in the heavens, and when it reaches *b* a whole fourth of the part the sun shines on is seen. When it reaches *c* we see half the part shone on; when at *d* we see rather more than half, and it is then called gibbous (Latin *gibbus*, hump-backed, meaning that she is swelled out and

nearly full); when at *e* we see the whole, and it is then said to be full; when at *f* it is gibbous again, and at *g* half moon. The moon is said to be eclipsed when it gets into the shadow of the earth, as shown in Fig. 2. In this S is the sun, E the earth, and M the moon. As the sun shines upon the earth, it makes a dark shadow behind it, and when the moon happens to get into this shadow, it can get no light from the sun, and no one on the earth can see it until it comes out of the shadow. While in the shadow it is said to be in eclipse. You may think, since the earth is all the time rolling round the sun, and the moon all the time round the earth, that the earth ought to come between the sun and the moon once every month, and that there ought to be therefore an eclipse of the moon every month. This would happen if the path or orbit of the moon around the earth were in the same direction as the orbit of the earth round the sun; but it is really a little slanted toward it, so that sometimes the moon is above the orbit of the earth round the sun and sometimes below it. It is only when the sun, earth, and moon come into a straight line, one behind the other, that the moon is eclipsed. The moon also makes eclipses of the SUN when she comes between the sun and the earth.

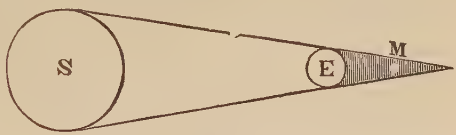


Fig. 2.—Eclipse of the Moon.

When we look at the moon with the naked eye its face appears to be mottled, some parts being light and others dark. When we look at it through a TELESCOPE, the surface is seen to be covered with mountains, valleys, and plains, much like the surface of the earth, but with this difference; everything in the moon is barren and desolate, like the country around volcanoes on the earth, and there are no seas, lakes, or rivers. Indeed, most people think there is no water at all in the moon; therefore, there can be no clouds to shade it from the sun, and no dew or rain to water it. It is also thought that there is no AIR around it, and so that no SOUND can be heard there.

Many photographs of the moon have been made by means of telescopes, and very good maps of her surface have also been drawn, on which the mountains and plains are named just as on maps of the earth. Some dark places on these maps are named seas, because the ancients supposed them to be water, but they are now known to be dry land.

Some of the mountains in the moon are in long ranges, and others rise like cones to a great height from level plains. Some of these mountains look much higher than any on the earth. There are also many high round ridges with level places inside them, from the middle of each of which a cone-shaped mountain rises. These look like great caverns or pits, with steep walls, often many thousand feet high. The floor of one of them is strewn with great blocks, and everything about them is rugged and desolate. But pictures of the moon taken at different times are not all alike, so it is thought that some changes are going on in it.

In looking at the moon we always see the same things, therefore it is known that we can see only one side of her, the other side being always turned from us. As she rolls round the earth once every month, she herself must also turn round once in just the same time, or else we should be able to see all sides of her. You will understand this if you place your hands on a post and go round it, keeping your face toward the post all the time. You will see that you

yourself turn round once each time you go round the post. So the moon turns round once each time that she rolls round the earth and thus always keeps the same face toward us. As the turning round of the EARTH makes the day on the earth, so the turning round of the moon makes the day in the moon; and as it takes the moon nearly a month to turn round once, so its days are each nearly a month long—that is, the sun shines there for about fourteen of our days, and then it is dark for about the same length of time.

The word moon is from the Anglo-Saxon *mona*, moon.

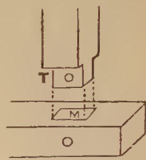
MOOSE. See ELK.

MOROCCO. See LEATHER.

MORTAR, a kind of cement put between stones and bricks to fasten them together. It is made mostly of slaked LIME, or lime which has been mixed with water and sand. Cow hair is sometimes put into it to hold it together when it is laid thickly or in a mass. Mortar is mixed thoroughly so as to form a smooth paste, which is spread with a trowel so as to fill up all the joints between stones and bricks laid in it. In time it becomes almost as hard as the stones themselves. The reason of its hardening is that the lime in it takes up CARBONIC ACID from the air and forms carbonate of lime (CALCIUM carbonate), which partly unites with the silica (see SILICON) of the sand, thus making a kind of stone. Mortar is also used for the first coating of plaster walls, but more hair is mixed with it than with mortar for brick and stone work, because this makes it hold on to the LATHS better. See CEMENT.

The word mortar is from the Latin *mortarium*, meaning anything crushed or ground, the things out of which mortar is made being sometimes ground fine.

MORTISE, a place cut into a beam, to hold the end of another beam, made to fit it, called a tenon. In the picture, M shows the mortise and T the tenon. When the tenon is put into the mortise, a wooden peg is usually driven through both, which keeps the tenon in place so that it cannot be pulled out. This kind of joint is much used by house carpenters in putting together the frames of houses, and in making doors, shutters, and blinds. Most of the locks on doors are fitted into mortises.



Mortise and Tennon.

The word mortise is in French *mortaise*. Tenon is in French *tenon*, from the Latin *tenere*, to hold.

MOSAIC, a kind of inland work made by fitting together little pieces of stone or glass of different colors so as to form a picture. There are two kinds of mosaic, called usually Roman and Florentine, from the cities of Rome and Florence, where they are chiefly made.

Roman Mosaics are pictures made up of little pieces of colored glass called *smalti* or smalts. The smalts are made in long slender rods of many thousands of different colors and shades, and are cut up into pieces of the sizes wanted. It is said that more than 26,000 different shades are used in making large pictures. A space of the size of the picture to be made is cut into a slab of stone, or a plate of metal with a raised margin about an inch high, is provided for the foundation of the mosaic. The bottom is covered with a kind of cement, and into this are stuck the little pieces which make up the picture. When all are set up the top is polished smooth, and the mosaic looks, at a little distance, like an oil painting. The ceilings of many of the churches in Rome are entirely of mosaic, as well as many of the altar pieces and wall decorations. A picture thus made is indestructible, and never loses its color. Some very ancient mosaics are preserved, which look as well now as when first made.

In Rome are many small shops where mosaic table tops, box covers, etc., are made. A workman works all his life on one subject; one making always a view of the Colosseum, another of St. Peter's, and a third of the Forum. Each one thus becomes so skilful that he can do his work quickly and cheaply.

Florentine Mosaics are made of real stones and pieces of shell instead of colored glass, and are mostly imitation of flowers, birds, insects, and other small things. They are made by inlaying little pieces of AGATE, JASPER, carnelian, MALACHITE, and other stones. The pieces are polished before they are put into place, because, as some of the stones are much softer than others, they cannot be polished after the work is done. Great care is necessary, therefore, to fit them into their right places.

The word mosiac is from the New Latin *mosaicum* (*opus*), mosaic work, probably from the Greek *mouseios*, belonging to the Muses, and therefore something well made.

MOSQUITO. There are several kinds of mosquitoes or gnats, and some of them are found almost everywhere, in the coldest as well as in the hottest countries. Those that live in swamps and woods are active only in the daytime, while house mosquitoes fly only by night, but all of them suck the blood of men and of animals. The bite of mosquitoes is really a sting, for instead of jaws they have a long hollow proboscis, or sucker, with several little bristles or lancets in it, sharper than the finest needle. These bristles prick through the skin and the insect then draws up the blood through the proboscis. At the same time a poisonous juice is squirted into the wound, which causes a great itching and sometimes makes a bad sore. The picture shows the proboscis of a mosquito, with the feelers around it as seen in a microscope. Male mosquitoes feed mostly on the juices of flowers, and do not sting human beings; the females are the ones whose music we hear at night and whose stings are so troublesome.

Head of Mosquito, showing Proboscis and Feelers.

Mosquitoes lay their eggs in still, fresh water, in ponds, cisterns, and ditches. Each female lays three hundred or more EGGS, which are formed like a little boat, and stuck together with a sort of glue. The boat, which is always of the same shape, is left to drift, the mother taking no further care of it. In a few days the larvæ (see INSECTS) crawl out at the bottom of the eggs and become what are called "wigglers." After about two weeks, during which they change their skins several times, they become pupæ, sometimes called "tumblers," because they tumble over and over in the water. In about ten days more the skin of the pupa opens on the back and the mosquito comes out. Many broods of mosquitoes are hatched every season, but great numbers of the pupæ are eaten by fishes and birds, or drowned in trying to get out of their cases. After the pupæ become full-grown mosquitoes also, thousands of them are eaten by other insects and by insect-eating birds. If it were not for this they would be a far worse pest than they now are.

Though always considered a pest, the mosquito has an important use.

It is a valuable scavenger and does much good by removing things that might make disease. It feeds on the decaying substances found in stagnant waters, and so helps to remove one of the causes of malarial fevers.

The mosquito belongs to the order *diptera*, or two-winged INSECTS, and to the gnat family.

The word mosquito is Spanish, and is a diminutive of the Spanish *mosca*, Latin *musca*, a fly.

MOSSES. These very interesting PLANTS have stems and leaves, and also something which answers for flowers and seed-vessels, but they are very simple and not much like those of the higher plants. None of the mosses are large, and many of them are very small. They grow better and in greater numbers in cool than in hot climates, and many are found on high mountain tops and far up in the Arctic regions. Next after the LICHENS, they are among the first plants which begin to cover rocks and bare places. They love dampness and often grow in bogs and swamps, which they slowly fill up. Trees, stone walls, and ruins are covered and made beautiful by them, and the shady banks of brooks are clothed by them with a green carpet as soft as velvet. By collecting sand and earth in their thick mat, mosses form a soil for other plants. They also cover and protect the roots of other plants in winter, and make lodging places and food for insects.

Hawk Moth.

Mosses are used to pack trees and plants, for littering cattle, and in some places for stuffing pillows and mattresses. Several kinds give food to cattle in cold countries, and even a poor quality of bread is sometimes made from mosses in the Arctic regions.

Mosses belong to the sub-kingdom of flowerless PLANTS, of which they form the second class.

The word moss is from the Latin *muscus*, plural *musci*, moss.

MOTH, an insect belonging to the same family with the BUTTERFLY, but which generally flies by night. There are many different kinds of moths, and they vary greatly in size, form, and color. The owl moth of Brazil measures eleven inches across the wings, while others are less than half an inch. Some kinds are very beautiful, but they are not so handsome as the butterflies. When at rest they do not hold their wings up like the butterflies, but have them usually flat or hanging down a little; and some of the smaller moths wrap them around the body. Moths pass through three changes of life in the same way with the butterflies (see CATERPILLAR).

The **Hawk Moth,** which is among the largest of common moths, is so called from its swift and strong flight. It is sometimes called hum-

ming-bird moth, because it makes a noise in flying somewhat like that of the humming-bird. In France children call it the bird-fly. Many hawk moths are so large and of such bright colors that they might easily be mistaken for birds as they fly from flower to flower in the dusk of evening. They sometimes light, but generally sip honey with their long proboscis or tongue while hovering over flowers. One of the pictures shows the form of one kind of hawk moth, and the other picture the

Cocoon of Hawk Moth.

shape of the cocoon or chrysalis (see INSECT) in which its pupa changes into a moth. The silkworm, which is a kind of moth, is told about under its own title.

The **Clothes Moth**, the larva of which eats clothing, carpets, and furs, is among the smallest of the moths. It is of a light buff color, the hind wings being nearly white, and its head is covered with little hairs. This moth, which begins to fly about in May, lays its eggs in woollens, on which the young feed. The larvæ are smooth and nearly white, and have sixteen legs. When ready to become pupæ, they make themselves little cases out of the cloth they eat, and fasten them together with silk which they spin. In these cases they live until they change into moths. There are other kinds which eat grain, fruits, and trees.

The moth belongs to the order *lepidoptera*, or scale-winged INSECTS.

The word moth is from the Anglo-Saxon *moththe*, moth.

MOTHER-OF-PEARL, the silvery substance, called nacre, with which the inside of many shells is lined. The most mother-of-pearl is got from the shells of the pearl oyster, and great quantities of them are brought every year from the East Indies, South America, and the Pacific islands, to be manufactured into knife handles, shirt buttons, and studs and ornaments. Much of it is also used in inlaying furniture and other cabinet work, and for ornamenting PAPIER-MACHÉ. Mother-of-pearl is made by the oyster in the same way in which pearls are made. When manufactured the shells are sawn up into the right sizes and shapes, and then ground on grindstones and polished.

In the conch shell the nacre is pink, and beautiful jewelry is often made of it. The pink PEARL is found in this shell.

MOUSE. The common house mouse came first from Europe and Asia, but is now found almost all over America. It is generally slate color, but is sometimes black and sometimes pure white. The white ones are ALBINOS, and do not differ from the others excepting in color. Singing mice are also like other mice, but make a faint noise somewhat like the chirp of a bird. The mouse often does much mischief in our houses, but it is a timid and harmless little animal, and should not be a cause of fright to anyone.

The **Deer Mouse**, which has a yellowish-brown back and white breast and feet, is also commonly found in houses and barns in the Northern United States, and often in trees, making a nest like that of a bird. It lives on grain and nuts, and is fond of Indian corn, but does not do much harm to the farmer.

The **Meadow Mouse**, sometimes called the field mouse, is larger and more clumsy in form than other mice, and lives in burrows in the ground, where it lays up a store of food for the winter. It never climbs trees, like the deer mouse, but does much harm by gnawing their bark, and also by eating fruit and grain.

The mouse is a MAMMAL of the order *rodentia*, or gnawing animals,

and of the same family with the RAT.

The word mouse is from the Latin *mus*, mouse.

MULBERRY, a kind of tree on the leaves of which silkworms are fed. There are several sorts, and silkworms will eat the leaves of all of them, but the one which causes them to make the finest and best silk is the white mulberry, which was first brought from China. It bears a yellowish-white fruit which is good to eat, but is not nearly so good as the fruit of the black mulberry, which grows in Southern Europe and in the United States south of New England. The black mulberry probably grew first in Persia. It is more valued for its fruit than the white kind. It was long cultivated in Italy for feeding silkworms, but as the silk produced was inferior, it was replaced by the white mulberry. It is still much grown in Greece.

The **Paper Mulberry** grows wild in China, Japan, and the Pacific islands. The Japanese and Chinese make paper from the bark of its young shoots. The thin, silky, yellow paper in which tea is packed is mulberry paper. The South Sea Islanders make a kind of cloth, called *tappa* or *kapa*, by beating thin sheets of the bark with mallets. It looks much like unbleached cotton cloth at first; but they often stamp it with very pretty colored figures. The thin paper called India paper, used by engravers for taking fine proofs of pictures, is also made of the bark of this tree.

The word mulberry is from the Anglo-Saxon *murberie*, which is from the Latin *morus*, Greek *morea*, the mulberry tree.

MULE, an animal, part ASS and part HORSE. The parents of a mule are always a male ass and a mare; the offspring of a male horse and a female ass is called a hinny. The mule has the head, ears, and tail of the ass, but in size and height is more like the horse. It is noted for being very sure-footed, and is therefore of great value for travelling in mountainous countries; and it is quicker-witted and can endure more than the horse. In ancient times mules were much used for riding, and they still are ridden in Spain, South America, and Africa. In Italy and Spain they are also driven in carriages. In South America long trains of loaded mules travel over the mountains, in single file, each train led by an old mare, called the *madrina* or godmother, which has a bell hung round her neck. The mules all know the sound of their own bell, and when several trains are mixed together, as they sometimes are at halting places, the different trains will all separate and follow each its own mare when the time comes to move again. Mules are largely raised in the Southern States for work on plantations.

The word mule is from the Latin *mulus*, mule.

MULLET. There are about seventy kinds of this fish in the world, of which two kinds are common on our coast. The striped mullet, which is caught along the Gulf of Mexico, and from southern California to Chili, and the silver mullet, from Massachusetts to the West Indies, and from Lower California to Peru. The latter has many names, such as jumping mullet, sand mullet, silver mullet, and fat-back, and on the coast of Connecticut small ones are called bluefish-mummichog. Mullet are very plentiful on the southern coast and make an important fishery. They are taken in rivers with seines and other nets, and are of all sizes from a half pound to six pounds. They are a popular food fish at the South, and are sold both fresh and salted.

MUSCLE. In the article MAN it is said that the flesh is rightly called muscle. The meat of all animals is made up of muscles, with generally a little fat, but they are not of the same color in all animals. In beef and mutton they are deep red, in

the meat of a rabbit lighter red, and in most of the meat of fowls nearly white.

Every movement of the body is made by muscles. They move the bones, so that we are able to walk, run, and leap, and to strike and grasp anything, and they also move the tongue, the eyes and eyelids, and other parts of the face and all the inner parts of the body, such as the heart and the stomach. Muscles are bundles of soft threadlike strings, all running in one way, which have the power of shortening and lengthening themselves. At each end they are joined on to harder and thinner parts, called tendons, by means of which they are fastened on to the bones or to some of the other firm parts of the body. The tendons are sometimes round like a cord, and sometimes flat and spread out, but they are always firmer, thinner, and more slender than the middle of the muscle. The tendons are always the same and do not shorten any, but the soft part of every muscle can suddenly shorten itself, and as quickly become long again. When it thus shortens itself it becomes thicker, and when it lengthens again it gets thin once more, just as a piece of India-rubber grows thin when it is stretched.

The muscles of the arms and legs are among those best known to us. If you bend your forearm up toward the shoulder, and at the same time put your other hand on your upper arm, you will feel the muscle thicken and grow harder. As it also shortens as it thickens, you will see that it is this which pulls up the arm. If you now stretch your arm out straight you will feel the muscle go down until it becomes thin again. There are other muscles in the arm, one of which, under the upper arms, helps to pull down the forearm when it is bent, but the large muscle which you feel on the front of the upper arm is the principal one. This is called the biceps (Latin *bis*, twice, and *caput*, head) or two-headed muscle, because its upper part ends in two tendons, other muscles having only one.

The forearm also is full of large muscles, most of those which move the hands and the fingers being there. If you open and shut your hand you can feel them work. There are no muscles in the wrist; it is filled with tendons which are fastened to the muscles above. You can feel some of these in your wrist, and others on the back of your hand. There are only a few small muscles in the hands, by means of which the fingers are spread out and brought together again. The muscles which do the hard work of the hand are in the forearm, where there is plenty of room for them, and they move the hand and fingers through the tendons which join them to them. The muscles which move the feet and toes are up in the leg, and do their work also through tendons, which go down through the ankle.

Some muscles, such as those of the arms and legs, can be moved at our pleasure; others, such as those of the throat, which are set in motion when we swallow, are sometimes moved by our will and sometimes not; and still others, like those which move the heart, act independently of us, that is, they move of themselves without any help from us. But, with only a few exceptions, most of the muscles can be moved by us at our will. We will to move our arm and we move it, the muscles shortening and lengthening as we choose. But how do the muscles know that we wish them to shorten or lengthen? Each one has many little soft white threads called NERVES scattered through it, which join it to the brain so that when the mind wills that the muscle should do anything, it sends it a message and the muscle at once obeys.

It takes a great many muscles to make all the movements of the body. There are in all more than five hun-

dred (527), of which all but five are in pairs. When we put into motion those muscles which we can move at will, we commonly call it taking exercise. Exercise not only tends to keep the body in a state of health, but it also enlarges and strengthens the muscles and makes them better able to do their work. The size and strength of the laborer comes from the use of his muscles, and a like fulness and force can be gained by anybody by a like exercise. Fat people are full and round in body, but they have little strength. They have thus a great weight to carry and little to carry it with. Fat comes from over-feeding and little exercise, and should be got rid of, if possible, by dieting and a proper use of the muscles.

The muscles of many of the lower animals are much more powerful than those of man. The muscular strength of insects is seen in the wonderful leap of the flea and the cricket, the power of beetles and ants to carry great weights, and of bees to fly great distances. Birds that fly high and swiftly have very strong muscles to work their wings. Fishes, too, have great muscular power, or they could not move so swiftly through the water. The strength of the elephant and the ox, the spring of the lion and the tiger, the speed of the antelope and the ostrich, the leap of the frog, the kangaroo, and the hare, and the squeezing powers of the boa constrictor and of some other serpents, are all instances of muscular force much greater than that of man.

The word muscle is from the Latin *musculus*, a muscle. *Musculus* really means a little mouse, from Latin, *mus*; the name is given to the muscles because some of them look, when in motion, like a little mouse.

MUSK, a perfume obtained from the musk-deer. This deer, which has no horns and differs in some other things from other deer, lives in the mountainous parts of Central Asia. The musk is a soft reddish-brown ointment, which grows in a small bag between the hinder legs of the male deer. When the deer is killed the musk bag is cut off and dried with the musk inside. Grain musk is a coarse brown powder gathered from stones, trees, etc., on which it has been rubbed off by the animal. Musk is one of the strongest of all perfumes, and is much used by perfumers. Other animals, such as the musk-ox, musk-rat, and musk-duck, smell of musk, and a drove of pigs will often leave the smell behind them, but none but the musk-deer gives the perfume. A kind of false musk is sometimes made out of AMBER.

The musk-deer is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word musk is from the Greek *moschos*, musk.

MUSKET. See RIFLE.

MUSK-OX, an animal living in the Arctic regions of America. It is between the ox and the sheep in looks, in size, and in some other respects, being generally about as large as a two-year-old cow, with broad flat horns bending downward like a ram's, and with brownish-black hair growing long like a goat's. The musk-ox is generally found in herds of a dozen or more, on rocky barren lands, where it feeds on grass, moss, and lichens. Though its legs are short, it can run very fast, and is not easily approached. The flesh, which is liked by the Esquimaux, smells strongly of musk, from which the animal gets its name. It is sometimes called musk-sheep.

MUSK-RAT, a small animal found only in America. It is sometimes called also musquash and musk-beaver. Its body is shaped like that of a rat, but is about the size of a rabbit, and is covered with thick, reddish-brown fur. It has small ears and eyes, a long tail, and short legs, with four toes on the front feet and five on the hinder ones. All the

toes are partly webbed; that is, they are joined by a skin between them to aid them in swimming. Though awkward on land, the musk-rat is a very lively and playful animal in the water, and can swim and dive with great ease.

Musk-rats live near streams or lakes, in the banks of which they usually dig holes, but on marshy lands they sometimes build houses like those of the beaver. The openings of their burrows or holes, of which there are generally two, one for high and one for low water, are made under water, and lead upward to dry ground above the reach of high water and freshets. Sometimes these burrows are forty to fifty feet long, and end in a gallery, where they make comfortable nests out of dried grass, leaves, and rushes, large enough for several to sleep in. From this gallery or chamber a small passage leads to the surface, the top ending in a bunch of grass or weeds, for ventilation.

The musk-rat has four to six young at a birth. They are helpless, hairless little creatures, not much larger than a mouse, and are fed by the mother in their underground house until nearly half grown. Sometimes, when their nest is flooded, they are drowned, unless rescued by the mother. A female musk-rat was once seen swimming during a flood with five little ones, each about as large as a common rat, holding on to the tufts of her hair while she slowly made her way along seeking for a new house. A mischievous boy threw a stone which struck the mother and scattered the young. The latter could neither dive nor swim, but with the mother's help they got to shore, where they hid in the reeds.

Musk-rats live mostly on grasses, roots, mussels, and fruits, but they will eat almost anything. Great numbers of them are killed and eaten by foxes, lynxes, and owls, and many are caught in traps and in other ways for their furs. They are caught in winter by trappers in a curious way. These animals often swim great distances under ice. They take in a long breath at starting, and then swim as far as they can. When they have used up all the OXYGEN in the air in their lungs, they came up and breathe out the air, which bubbles up against the under side of the ice. The bubbles take up oxygen again from the water and the ice, and the musk-rats breathe it in and then go on until they need more, when they do the same thing. In this way they can travel a long time in the water under ice. When the ice is clear they can be seen swimming below. The trapper follows until he sees one come up to renew its breath and, before it has time to take in its air again, strikes the ice with a hatchet directly over it, scattering the air bubbles and driving the musk-rat away. As it can get no more air, it soon drowns, and the trapper cuts a hole through the ice and takes it out. Musk-rat fur was once much used in making felt hats, but now it is usually made into cheap furs. The furriers call it "river sable."

The musk-rat is a MAMMAL of the order *rodentia*, or gnawing animals, and of the rat family.

The musk-rat is so called because it smells of MUSK. Its Indian name is musquash.

MUSLIN, a fine kind of cotton cloth. Muslin is not woven so closely as common cotton cloth, so that it is thinner and more like gauze. The finest muslins used to be made in India, and they were of such wonderful fineness that they were often spoken of as "woven wind"; but European muslins, made by machinery, have now taken their place, though they are not so soft and delicate as the Indian hand-made ones. Printed muslins are made in the same way as calico. The best are made in France, Great

Britain, and the United States. A cloth made of half wool and half cotton, and afterward printed in colors, is called by the French *mousseline de laine* (wool muslin).

The word muslin is from the French *mousseline*, named from Moussul or Mosul, in Asiatic Turkey, where this cloth was first made.

MUSSEL, a small shell-fish, somewhat like a clam but smaller, having a nearly three-cornered shell, greenish black on the outside and purplish white inside. Mussels are found both in salt and in fresh water. The common salt water mussel has a yellow meat, which is much eaten in Europe, both raw and cooked. As it is cheaper than the oyster, it is often called the poor man's oyster. There are vast beds of mussels on the Atlantic coast of France, near Rochelle, and thousands of people are employed in gathering them. The mud flats where they grow, which are called *bouchots*, or parks, are covered with rows of tall posts twisted full of wicker-work, on which the mussels fasten themselves. Sometimes these rows are two or three miles long. As the flats are covered by the sea at every tide, the mud, after the water has left it, is too soft to bear the weight of a man, so the fishermen, or *boucholeurs*, have little flat-bottomed boats, called

Boucholeur in his Acon.

acons, with which they slide over the mud, as shown in the picture. Only one knee is put into the acon, the fisherman pushing it along with the other foot, by which means it is made to go quite fast. The mussels have to be moved three or four times before they are ready for market. Mussels are sometimes eaten in this country, and they are also used for fish bait.

Fresh-water mussels are found in many rivers and streams in the United States. Several kinds have pearls in them, and some very fine ones were once found in New Jersey, one of which was sold for $2200. This set a great many people to looking for mussel pearls, and much time was wasted in the search which might have been better spent. Fresh-water mussels are seldom eaten, but they make good fish bait.

The mussel is a MOLLUSK.

The word mussel is from the Latin *musculus*, a mussel.

MUSTARD, a seasoning made of the bruised seeds of the mustard plant. The mustard shrub, which was brought to this country from Europe, is an annual PLANT, about two feet high, with sweet-smelling yellow flowers, and seeds in little pods. There are two kinds, white mustard, which bears yellow seeds, and black mustard, which has black

seeds. Both kinds of seeds are used for making table mustard. They are first ground in a mill, then bruised in a mortar, and finally sifted to get out the husks, from which a kind of oil is afterward pressed. Sometimes the husks are used to mix with black pepper. Mustard is much used in medicine, being given as an emetic to produce vomiting, in cases of poisoning; it is also put on the skin in the form of a plaster, and is so heating and irritating that if left on too long it will make a blister. In the United States mustard to be used on the table is usually mixed with water or vinegar and a little salt; but the French cook it, and flavor it with various things, such as garlic, cloves, and celery seed.

The word mustard is from the Old French *moustarde,* which is from the Latin *mustum*, must, or sweet wine which has not worked, with which mustard was mixed.

MYRRH, a pleasant smelling gum resin, with a sharp bitter taste, brought chiefly from Arabia and Abyssinia. It is the hardened juice of several kinds of shrubs or small trees which grow in those countries, and is at first light yellow, but when dry, reddish brown. It is used in medicine as a tonic, to dress wounds that are slow in healing, and as a tooth powder to rub the gums with when they are spongy or sore.

The word myrrh is from the Latin *myrrha*, Greek *murra*, which is from the Arabic *murr*, bitter.

MYRTLE. The common myrtle of Europe is a shrub which sometimes grows three times as high as a man. It has bright shining leaves, and bears single white or pink flowers, and black berries. In ancient times this plant was sacred to Venus, and her temples were surrounded by groves of it. The victors in the Olympic games were crowned with wreaths of its leaves. Its buds and berries were also used to flavor food, and as a medicine. At the present day the myrtle is used mostly as a perfume. Its leaves mixed with other things are made into sachet powders, and a strong-smelling water, called *eau d'ange*, is distilled (see ALCOHOL) from its flowers. Bay rum is made from the leaves of a kind of myrtle which grows in the West Indies.

The running plant commonly called myrtle in the United States is not a true myrtle, but is rightly named periwinkle.

The word myrtle is from the Latin *myrtus*, Greek *murtos*, myrtle.

N

NAIL. Nails are usually divided into cut nails, so called because they are cut out of iron plates, and wrought nails, which are made from wrought IRON. Different kinds are named from their uses, shape, etc., as shingle, clapboard, floor, horseshoe, trunk, and harness nails, and tacks, brads, and spikes. Some are called also four penny, six penny, eight penny, and ten penny nails. The word penny, thus used, is supposed to have been changed from pound. A six-pound nail was one of which it took a thousand to make six pounds, an eight-pound nail one of which it took a thousand to make eight pounds, etc. So a six pound nail, pronounced "sixpun-nail," soon came to be called a six-penny nail, and the same with the other sizes.

Before the present century almost all nails were made by hand, but now all kinds are made by machines, the best of which were first built in the United States. For making cut nails the iron is first rolled into plates of the thickness and a little wider than the length of the nail to be made. A plate is then put into the machine, and the dies or cutters cut off a tapering blank from its end. This blank is then seized and held tight by iron jaws, while a punch strikes the larger end and makes the head. The nail then drops out of the machine, and the plate moves up under the cutters and another tapering blank is cut, the wide part being this time on the other side, so that there shall be no waste in cutting up the whole plate. In this way the head of every other nail is made on the side of the plate opposite to that on which the head of the one before was made.

Wrought nails, such as horseshoe nails, and others, are also made now almost entirely by machinery. Shoe nails are small spike-shaped nails without heads; the smaller kinds are cut out of zinc plates, and the larger ones from iron plates. Many kinds of ornamental nails, such as picture nails for hanging up pictures, coffin nails, and furniture nails, are now made with wrought-iron shanks and porcelain or metal heads.

The word nail is from the Anglo-Saxon *nægel*, nail.

NANKEEN, a yellowish or buff-colored cotton cloth. The best is brought from China, where it is made out of a kind of yellow cotton, which grows near Nanking. Some nankeens are made in England, but they are dyed yellow, instead of being made of cotton which grows of that color, and they are apt to fade.

Nankeen is named from Nanking, China, where it was first made.

NARWHAL, a sea mammal, called also sea-unicorn and unicorn-fish. It is generally 15 or 16 feet long, and has a spiral tusk 6 to 8 feet additional, of solid ivory. The narwhal is dark gray above with darker spots, and white on the sides and below. It is an active, powerful animal, and is often seen playing in schools of 10 to 20, swimming with its tusk out of water. One has been known to drive his tusk deep into the timbers of a whale ship. The Greenlanders, who take them with harpoons, value them greatly for their flesh, oil, and ivory. The flesh is considered a great delicacy, and

their blubber makes a fine oil. The ivory of the tusks is hard and white.

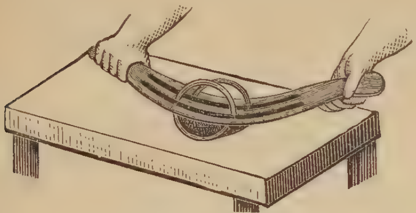


Fig. 1.—Straightening the Wires.

The narwhal is a MAMMAL of the order *cetacea*.

The word narwhal is in Icelandic *nahvalr*, corpse whale, from *na*, a corpse, and *hvalr*, whale. It is so called from its color.

NEEDLE. The sewing needle looks like a very simple little thing, yet each one that is made passes

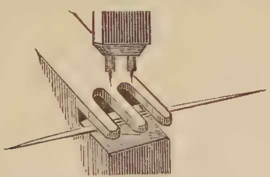


Fig. 2.—Punching the Eyes.

through the hands of nearly one hundred workmen. Needles are made out of fine steel wire, which comes rolled up in coils. The needle maker cuts the wire into small pieces called blanks, each of which is as long as two needles. As these blanks are cut from coiled wire they are bent a little, and the first thing to be done is to straighten

Fig. 3.—Needle Blanks.

them. A great many of them are placed together in two strong iron rings, heated red-hot and cooled slowly so as to soften them, and then rolled over and over with an instrument called a smooth-file, as shown in the picture (Fig. 1). It will be seen that the smooth-file has two slits in it, through which the rings pass, so that it comes right on to the wires and rolls them out straight. The blanks are then gronnd sharp at both ends on small grindstones.

The middle of each one is next flattened and grooves made on each side in a stamping machine,

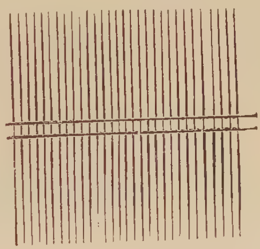


Fig. 4.—Stringing the Blanks.

which also makes little dents where the eyes are to be. The eyes are punched through in a small hand press, shown in Fig. 2, which is

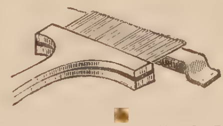


Fig. 5.—Row of Needles in Vice.

worked by a boy. One blank at a time is put under the press, the boy pulls a handle, and the two steel punches are pressed down through the dents made by the stamping machine. In Fig. 3, *a* shows the blank after it has been sharpened; *b*, after it has been grooved and dented; and *c*, after the eye has been punched.

The blanks are now strung by

running two fine wires through the eyes, as shown in Fig. 4, and are then bent backward and forward until they break in two in the middle, each blank thus making two needles.

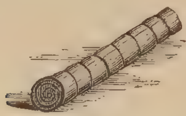


Fig. 6.—Roll ready for Scouring.

Each row of needles, still strung on the wire through the eyes, is put into a kind of hand vice, as shown in Fig. 5, and held firmly while the heads are filed into shape. They are next

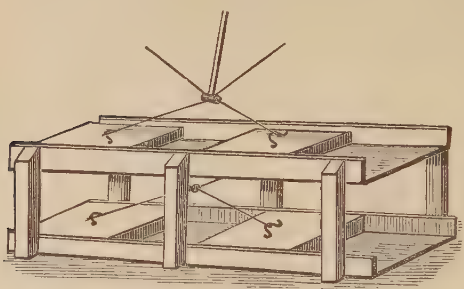


Fig. 7.—Scouring Needles.

straightened again, then heated red-hot and cooled quickly in cold oil, and then tempered by heating them again slowly and letting them cool slowly.

They now have the form of needles, but are black and not very smooth, and have to be brightened and polished. A great many of them are rolled up together in pieces of canvas with some soft-soap, emery, and oil, and wound round with twine so as to make a roll, as shown in Fig 6. Several of these rolls, which are usually about a yard long, are laid on a kind of table with sides to it, as shown in Fig. 7, and rolled over and over under flat blocks of stone, which are moved backward and forward by machinery. This rolling goes on usually for two or three days, and sometimes as long as a week in making very fine needles; and, as the canvas soon wears out, the rolls have to be made up new about once in eight hours. In some factories needles are scoured by rolling them around in barrels. After scouring, they are washed, and a little girl, called the "header," then sorts them by putting the heads all one way. She does this very easily and quickly by pressing her finger, which is covered with a piece of wash leather, against one end of a pile of needles, when all with their points that way stick to the leather and are pulled out and laid right. The eyes are then blued by laying a row of needles on a steel slab so that the eyes just stick out over the edge, and holding a red-hot iron plate near them. The insides of the eyes are next drilled smooth by holding each needle against a little steel drill which turns round very fast, and the needles are then finished by polishing them on leather-covered wheels with a little polishing PASTE. They are lastly folded in colored papers, twenty-five in each paper, and labelled, when they are ready to be made up into large packets for market.

This is the way of making the finest kind of English needles, but not so much care is taken with the coarser kinds. Needles are made in France out of iron wire, which is afterward made into steel, but they are not so good as English needles. Several machines for making needles have been built in this country, and many needles are now made by them. In one of them blanks long enough for two needles are put into a hopper, or kind of box, from which one at a time is carried into the machine and finally falls out at the end a full-made needle, ready for scouring.

The word needle is from the Anglo-Saxon *nædl*, needle.

NEPTUNE, one of the planets of the solar system (see UNIVERSE). It is the outermost of the planets, being 2,800,000,000 miles distant from the sun. Though excelled only in size by Jupiter and Saturn, it is too far away to be seen by the naked eye. Seen through a telescope Neptune is a pale greenish blue. Its diameter is 37,000 miles, and it is therefore about 80 times as large as the earth. It goes round the sun once in 164 years. Only one moon or satellite is known.

Neptune was discovered in 1846. From the movements of Uranus, astronomers thought there must be another planet to cause those movements, and Leverrier, a French mathematician and astronomer, and Amdas, a student in Cambridge University, set out to calculate its probable position. Both worked out the problem, but the planet was discovered by Dr. Galle of the observatory at Berlin from Leverrier's calculations.

Neptune was named from the god Neptune.

NERVES. In the article MAN it is told that the skull is so fitted upon the backbone that its hollow part comes right above the canal which runs down through the backbone. In fact its hollow is only a continuation of the hollow through the backbone, swelled out into a rounded space. This space is filled with the brain, made up of a delicate whitish matter, which tapers off at the bottom into a thick white cord and runs down through the backbone. The cord part is called the spinal cord, spine being another name for the backbone, on account of the spines or thorn-like points which stick out from it. Though the brain and the spinal cord have different names, they are so joined together that it is hard to tell where the one ends and the other begins.

The matter of which the brain and the spinal cord are made up is called nervous matter, and from it branch little cords, called nerves, which run to all parts of the body. The nerves which come from the brain pass through holes in the bottom part of the skull, and spread out irregularly, but those which come from the spinal cord are much more regular, branching out from between each of the joints of the back bone, where there are little hollows for them. These spinal nerves, as they are called, soon divide into branches which spread out into the different parts of the body, and again divide into smaller branches, which keep on dividing until they form the finest of white threads, too small to be seen. The nerves which come from the brain are joined chiefly to the organs of the senses, such as the eye, the nose, the mouth, and the ear; those which come from the spinal cord are joined mainly to the muscles and to the skin of the neck, body, and limbs.

The brain is the seat of the mind, which governs all the movements of the body; and it is through the nerves that the mind knows of what is going on outside of the body and sends its orders to the muscles which move the different parts. When we see, smell, taste, or hear anything, the nerves carry the news to the brain, and in this way we know that we see, smell, taste, and hear. If the nerves joining the eye with the brain should be cut, we would not be able to see anything; and if those which join the ear with the brain were cut, we could not hear anything. The eye would form its image just the same, and the drum of the ear would still be moved by sound-waves, but we should never know of them if we had no nerves to telegraph the news to the brain. The sense of touch is common to all parts of the body, but wherever we feel anything, whether it be in the face or in parts more distant from the brain, such as the fingers and the toes, the brain at once knows of it through

the nerves, whose little threads reach out everywhere.

Thus all our sensations of sight, of smell, of taste, of hearing, and of touch, are carried to the brain by the nerves. But the nerves have also another duty, that of carrying the will of the brain to the different muscles, by means of which all the movements of the body are made. In the article MUSCLES it is told that most of the muscles can be moved by us at our will. In the muscle called the biceps, which lies on the front of the upper arm and by means of which the forearm is bent up, are several little thread-like nerves. After leaving the biceps they are soon met with others which join them and form thicker nerve cords. These join others and thus become thicker again, until at last they join one of the nerves which come out from between the joints of the backbone somewhere in the neck, and thus become united with the spinal cord, and through it with the brain. Thus the biceps muscle is joined to the brain. Now, when you will to bend your arm, the brain telegraphs through the nerves to this muscle, which at once swells up and shortens, and thus draws up your forearm. If by any chance the little threads which go into the muscle should become broken, you would find that you were unable to bend your arm. You might will it ever so much, but the muscle would stay quiet and your arm would not move. It is the same with the other muscles of the body. Each one is joined to the brain by nerves, and thus all the movements of the body are caused by the brain.

There are then two kinds of nerves: those which carry feelings or sensations from the skin and other organs of sense to the brain, and therefore called sensory nerves; and those which carry the will of the brain to the muscles, and so cause them to move, and therefore called motor nerves. Motor nerves have only one kind of work to do, but as there are several senses, so there are several kinds of sensory nerves. We can easily tell whether anything is rough and smooth, hot or cold, wet or dry, by feeling it with the finger, but we cannot tell the difference between sweet and sour things in that way. The tongue, however, at once finds out the difference, because it is joined to the brain by sensory nerves of another kind. So also the sensory nerves of sight, smell, and hearing differ from those of taste and of touch, but exactly in what way is hard to tell.

The word nerve is from the Latin *nervus*, Greek *neuron*, a nerve or sinew.

NETS. Fishing nets are made commonly of hemp or flax twine, but some are made of cotton and some of jute and other materials. The threads are not woven across each other close together as in cloth, but wide apart, so as to make square holes called meshes, each thread being fastened where it crosses another one by a kind of knot. The size of the meshes and of the twine differs in different kinds of nets. For a long time nets were knit by hand, and a good many are still made in this way by fishermen and their families, but they are now knit mostly by machinery.

Fishermen have many kinds, but those most in use are the seine, drift, and trawl nets. The seine is a very long but not very wide net, one side of which is loaded with pieces of lead, and the other or upper side with floats made of cork. When let down into the water the upper side floats and the lower side hangs down straight; so that when stretched out it forms a kind of long wall, in which, by bringing the ends together, great schools or shoals of fish may be enclosed. Seines are of many sizes, some used for taking shad being sometimes a mile long; and one used in the Potomac River in 1871 was nearly two miles long. Such large

seines are worked by horses or oxen turning a windlass, and sometimes by a steam engine.

The drift net is made like the seine, but has no leads on the bottom. The trawl net is a kind of drag net for catching fish which swim near the bottom. It is usually dragged along by the fishing boat. The hand or scoop net is a small net hung on a hoop at the end of a pole, and is used to catch small fish, crabs, etc., by scooping them up from the water. Different kinds of nets are used also for catching birds and small quadrupeds, and sometimes broad nets are spread over fruit trees to keep the birds away from them.

The word net is Anglo-Saxon. Seine is from the Latin *sagena*, Greek *sagene*, a fishing net.

NETTLE, the name of plants covered with fine stinging hairs, which cause a painful smarting in the skin. The hairs are very sharp and so brittle that they break off, and the poisonous juice of the plant then flows into the wound. Animals will not eat growing nettles, but they like them when dried in hay, and in Sweden they are raised to feed to cattle. The fibre of the nettle is very strong, and in the northern countries of Europe it is used for thread, and fish lines and twine are made of it. It has also been woven into cloth. Young nettle shoots are sometimes boiled for greens, and in some parts of England the stalks and leaves are made into a kind of beer.

The word nettle is from the Anglo-Saxon *netele*, the nettle plant.

NICKEL, a METAL, one of the ELEMENTS. When pure it is silvery white, and does not oxidize or tarnish in the air. It can easily be hammered out into thin sheets or drawn into wire, is stronger than iron, and is almost as hard to melt as iron. Nickel is found in many parts of the world, but chiefly in New Caledonia, Russia, Sweden, Germany, Austria, England, and Scotland; and in America, at Sudbury, Ontario, Canada, in Pennsylvania, Connecticut, and Oregon. It is hard to separate it from its ores, as it is usually mixed with a good many other things.

The chief use of nickel is for plating other metals, to which it gives a beautiful silver-like surface that keeps them from rusting. Among the things now plated with it are knives, forks, tea-sets, buckles, bits, skates, surgical instruments, the scales of thermometers, the arms of railway seats, chandeliers, and gas fixtures. The copper rollers used in calico printing are now also plated with nickel, such rollers lasting three or four times as long as plain copper ones, which are much softer.

Several valuable ALLOYS are made with nickel, among which is German silver, made up of one part of nickel, one part zinc, and two parts of copper. The best German silver is nearly as white as pure silver, and takes a fine polish. The copper coins of several European countries are alloys of nickel. In the United States we have five-cent pieces and three-cent pieces made of three parts of copper and one part of nickel. But the most important of the nickel alloys is that made with steel. By mixing with steel a small percentage of nickel, the steel is made harder, stronger, and more elastic, and less liable to corrode or rust. This makes nickel-steel far more valuable than common steel for many important uses, such as making armor-plates for ships, building bridges, and other purposes were great strength is required.

Nickel was first found out about a hundred years ago (1751) in a kind of ore called by the old miners *kupfernickel*, Nick's copper or false copper, because, though it looked much like copper ore, they could never get any copper out of it. The word is made up of *kupfer*, copper, and *nickel*, a short form of Nicholas, a name sometimes given to the Devil, and our word nickel comes from this.

NIGHTHAWK. This bird is wrongly named, for it is not a hawk, and it does not fly by night. In the South it is commonly called bullbat, though it is not a bat. It belongs to the same family with the whippoorwill and, like it, may often be seen at twilight flying swiftly with its large mouth wide open in search of insects. It is nine or ten inches long, with plumage of greenish-black, brown, gray, and tawny shades, and with wings which stretch nearly two feet. It is found all over North America, from the West Indies to Nova Scotia ; it comes North in spring and returns South in autumn, where it is much esteemed for food, as it is then fat and juicy.

The nighthawk belongs to the order *insessores*, or perching birds.

NIGHT-HERON. The common night heron of America is about two feet long, with yellow legs, and a black bill of about three inches. The upper part is greenish black, and the other parts bluish-gray, shading into white. It is found almost all over the United States, going north in the spring as far as Maine. It builds a nest of coarse sticks on bushes or trees in swampy places near the coast, and often returns and rebuilds the same nest year after year. Its eggs, generally four, are pale sea-green. The night-heron feeds upon fish, reptiles, crustaceans, and even mice and other small animals. It is sometimes called qua-bird and squawk from its hoarse cry.

The night-heron belongs to the order *grallatores*, or wading birds.

NIGHTINGALE. This bird, famous in poetry and song, is not handsome. It is generally about 6[1] inches long, is reddish-brown above and pale grayish-brown below, whitening on the throat and breast. It passes the winter in Northern Africa, and spreads nearly all over Europe in the spring, appearing in England about the middle of April. The nightingale lives in woods, copses, and hedge-rows, and feeds on wasps, ants, and other insects, soft berries, and fruits. It is shy and keeps concealed among foliage, where it is oftener heard than seen. It sings sometimes during the day, but oftener for an hour or two after sunset, and on clear moonlit nights it may be heard until midnight. The song, which is celebrated, is the love-song of the male; the female does not sing. It is very sweet, but not so sweet nor so powerful as that of the mocking-bird. The nightingale builds its nest on the ground in thickets and lays four or five pale brown eggs. The poets call this bird philomel or philomela, from Philomela, daughter of Pandion, king of Athens, who was changed into a nightingale (Greek *philein*, to love, *melos*, song).

The nightingale belongs to the order *insessores*, or perching birds.

The word nightingale is from the Anglo-Saxon *nihtegale*, from *nihte*, night, and *gali*, singer.

NITRE. See SALTPETRE.

NITRIC ACID, a thin strong liquid made up of HYDROGEN, NITROGEN, and OXYGEN. It is about half as heavy again as water, and when pure is colorless, but is generally yellowish. It is a very biting liquid, and will quickly char or burn and turn yellow most animal and vegetable substances. On this account it was called in old times *aqua fortis* (Latin, strong water), and it is still commonly known by that name. Nitric acid will easily mix with water, and that generally sold has in it one-half, or two-thirds water. It is commonly made out of nitre or SALTPETRE, or from Chili saltpetre, sometimes called soda-nitre, a kind of SALT gathered on a desert in Chili and Peru. Common saltpetre has POTASSIUM in it, while Chili saltpetre has SODIUM instead of it. Either one of these substances is heated with SULPHURIC ACID in earthenware vessels, or in iron vessels coated on the inside with clay ; the sulphuric acid unites with the potash or the

soda, and leaves the nitric acid separated.

Nitric acid is much used in the arts, to act on metals, earths, liquids, and other things. Etching (see ENGRAVING) on copper is done with it, tin for making mordants for DYES is dissolved in it, and it is of great importance in getting metals from ores. When mixed with muriatic ACID it forms *aqua regia*, the only thing which will dissolve gold. It is sometimes given in weak doses as a medicine, and is also used as a CAUSTIC. Nitric acid joins with BASES to form nitrates, which are of greater value than the acid itself. These are made up of nitrogen, oxygen, and some metals; for instance, silver nitrate is nitrogen, oxygen, and silver, and potassium nitrate (SALPETRE) is nitrogen oxygen, and potassium.

Nitric acid gets its name from nitre, Latin *nitrum*, Greek *nitron*, saltpetre, and ACID.

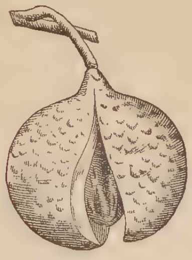
NITROGEN, one of the principal ELEMENTS. Nitrogen forms four-fifths of the AIR, and makes up a part of all animals and vegetables. In its usual form, it is a gas without color, taste, or smell, and not quite so heavy as air; but it may be changed into a liquid by a great amount of cold and of pressure. Nitrogen is not at all like OXYGEN, which is mixed with it in the air. Instead of being lively and showing a desire to unite with other substances, it is very mild and unites with only a few other things. Flame will go out and animals will die in it. But it does not really put out flame, nor kill animals; flame goes out and animals die in it because there is no oxygen. They are suffocated, just as a drowning man is, by being cut off from the air. Although nitrogen will not keep up life, it is of great importance in the world. If it were not mixed with the oxygen in the air, we could not live long, and everything that can burn would be likely to burn up. The chief use of nitrogen, then, is to mix with the oxygen in the air so as to make it fit to be breathed by us.

Though nitrogen is a very mild substance when in the air, and though it shows a general dislike to other substances, it will unite with a few other things; and when it does unite thus it forms some of the most powerful of compounds, such as NITRIC ACID, or *aqua fortis*, AMMONIA, or hartshorn, nitro-GLYCERINE, and prussic ACID.

The word nitrogen, which means nitre-maker, is made from the Greek *nitro*, nitre, and *gennein*, to make; and nitrogen is so called because it is always a part of nitre or SALTPETRE.

NOVEMBER. See CALENDAR.

NUTMEG, the fruit of the nutmeg tree, which grows wild in the Moluccas, where it was long cultivated by the Dutch. When the English owned the islands, at the



Nutmeg.

end of the last century, they carried some trees to Bencoolen and Prince Edward's Islands, whence the nutmeg spread to Bourbon, Mauritius, Madagascar, the West India islands and South America. The fruit, when ripe, is golden yellow, and looks like a round pear. It has a hard fleshy part, something like candied fruit, which is preserved and eaten as a sweetmeat. Within this is the nut, in a thin, shining brown shell, enclosed in a bright-red network, which is the mace of commerce. Mace, when dried in the sun and

pressed, becomes yellow. The inner nut is the nutmeg, which is used mostly as a spice. The oil of mace is made by pressing nutmegs, and not mace as is generally supposed.

The word nutmeg is made from the Latin words *nux*, nut, and *muscus*, musk, and therefore means musk nut. In England, in old times, it was quite fashionable to use nutmegs as a perfume, and it was no uncommon sight to see one set in silver, and ornamented with pearls and precious stones, hanging from a lady's belt, like a modern scent bottle.

NUTRIA, the fur of a South American animal called coypu, much used by hatters. The coypu, racoonda, or couia looks like a small beaver, but has a long round tail like that of a musk-rat. It lives in holes in the banks of rivers and along the seashore, and is a good swimmer, but awkward on land. Its fur, which is long and mixed light-red and brown, is made into felt hats.

The word *nutria* or *nutra* is the Spanish name of the coypu.

O

OAK, the name of an important kind of tree belonging to the same family with the CHESTNUT and the BEECH. Oaks grow in almost all cool countries, and some are found in warm countries. They are among the largest and finest of forest trees, and have strong and hardy trunks and wide spreading branches. Some oaks shed their leaves every year and some are evergreens, and the leaves of the different kinds vary much in shape and color; but all are alike in their fruits, which are called ACORNS. The most valuable timbers are furnished by the oaks, and their barks are put to many uses, especially tanning, dyeing, and making CORKS.

The **White Oak,** so called from the light gray color of its bark, which grows almost all over the Eastern United States, from northern Maine to Florida, and west to Missouri and Kansas, is one of the most important of the oaks. It is a beautiful shade tree, and very valuable on account of the hardness and toughness of its wood, which is much used for ship-building, wagon-making, farmers' tools, cabinet-making, cooperage, railway ties, fencing, fuel, etc. Quantities of white oak staves are sent to Europe and to California for making wine casks. Its wood makes good charcoal, but is not so good for fuel as hickory. Its bark is excellent for tanning leather.

The **Burr Oak** and the **Rough White Oak** are found from New England through the Southern and Western States, and are almost as valuable as the white oak for ship-building, etc.

The **Live Oak,** which is one of the best of all trees for ship-building and for any kind of wood-work under water, grows along the coast from Virginia to Texas. It is an evergreen, and has thick shiny leaves, which, unlike those of most other kinds of oaks, are smooth, or without teeth, on the edges. The tree is very large, with wide-spreading branches; its wood is yellow and close-grained.

The **Holm,** or **Holly,** the evergreen oak of Europe, grows usually near the sea-coast. It also is much prized for ship-building.

The **Common European Oak,** sometimes called the British oak and royal oak, which grows almost all over Europe and in Western Asia, is the kind most used for cabinet work. It does well when planted in the United States. Most of the oak furniture in use is made of the wood of this oak.

Oaks which yield dyes are the black or yellow-barked oak, from the bark of which the yellow dye called *quercitron* is made, and the kermes oak, a kind of shrub growing on the eastern shores of the Mediterranean, from which a scarlet dye is obtained. This scarlet dye does not come from the oak itself, but from the dried bodies of an insect, something like the COCHINEAL insect, which feeds on its leaves. They are round and about as large as a pea, and are called *kermes*.

The word oak is from the Anglo-Saxon *ac*, oak.

OATS, the grain of a kind of grass of the same name, which grows mostly in cool climates. The oat grew first in the cool parts of Eastern Europe. It was unknown to the ancient Egyptians and Hebrews;

and, though cultivated early in the countries north of Italy and Greece, was not raised in the Roman Empire until after the time of Christ. The oat differs in looks from WHEAT, RYE, or BARLEY, especially in the grains, which grow on many little branches, as shown in the picture, instead of in an ear. It will grow in colder and wetter climates and on poorer soils than other grains, except-

Oats.

ing coarse kinds of barley, and is therefore much raised in northern countries. The grains contain much starch, some sugar, gum, and oil, and a good deal of nitrogenous matter (see FOOD). They form a great part of the food of the common people in Scotland, where they are ground into meal and made into cakes and porridge. The Scotch porridge is made in the same way as hasty pudding, and is usually eaten cold with milk. Much of it is now eaten in this country, and it is a very strong and healthful food. Oaten groats or grits are the whole grains freed from the husks. Those made at Emden, in Prussia, and therefore called Emden groats, are crushed into small pieces.

Oats are sometimes mixed with barley in distillation (see ALCOHOL), and in Russia a liquor called *quass* is made from them. But the chief use of oats is for feeding horses, which like this grain better than any other. The husks also are mixed with other food and fed to horses, cattle, and sheep, and the straw is the best of all straws for fodder.

The word oat is from the Anglo-Saxon *ate*, oat.

OBELISK, a kind of monument erected in ancient Egypt, to record the honors and triumphs of kings. Obelisks were generally set up in pairs, one on each side of the entrance to a temple. They were hewn out of a single block of stone, were broader at the base than above, and had a pointed top like a pyramid, generally sheathed with a bronze cap. Some of them were more than a hundred feet high. Their sides were sculptured with hieroglyphs and figures recording the names and titles of the kings who erected them.

Many obelisks have been removed from Egypt in both ancient and modern times. The Emperor Augustus sent two to Rome, and other emperors followed his example. Two obelisks, formerly at Alexandria, called Cleopatra's Needles, were given by Mehemet Ali, ruler of Egypt, to Great Britain and France. The French took instead of the one offered them the obelisk of Luxor, and set it up in 1833 in the Place de la Concorde, Paris. The one given to the British was not removed until 1878, when it was erected on the Thames Embankment, London. Its companion was afterward given to the City of New York, and was set up in 1881 in Central Park.

The word obelisk is from the Latin *obeliscus*, Greek *obeliskos*, from *obelos*, a spit or pointed pillar.

OBOE. See HAUTBOY.

OCTOBER. See CALENDAR.

OCTOPUS. See MOLLUSKS.

ODOMETER, an instrument for measuring distance. One kind, attached to a carriage wheel, records

the number of times the wheel turns round, and the circumference of the wheel being known it is easy to calculate the distance travelled. This kind of odometer was used by the ancient Romans. Another kind used by surveyors, which works on the same principle, is a wheel to be drawn or pushed by hand. The pocket odometer, called also a pedometer, may be carried in the pocket like a watch. The rising and falling of the body in walking, moves the machinery inside it and that moves the index hand on the face.

Odometer means way-measurer, from Greek *odos*, way, and *metron*, measure. Pedometer means foot-measurer, from Latin *pes*, foot, and Greek *metron*, measure.

OILS. There are two kinds of oils, one called fixed oils, and the other essential or volatile oils. The fixed oils, which include also fats, are sometimes a thin liquid, like olive oil, and sometimes a solid, like lard or beef tallow. They will all melt at a lower heat than is needed to boil water, but they cannot be distilled (see ALCOHOL), that is, heat will not turn them into a vapor which, when cold, will turn back into oil again. For this reason they are called fixed oils. But the essential oils (so called because they contain the essential part or essence of the plants from which they are made, from Latin *essentia*, essence, *esse*, to be) will all pass off in vapor at common temperatures or heats. For this reason they are called also volatile oils (from Latin *volare*, to fly away).

Fixed Oils are obtained from both animals and vegetables. The most important solid animal fats are lard, butter, and tallow; the chief solid vegetable fats are palm oil, cocoanut oil, and butter of cacao. The most useful fluid oils obtained from animals are sperm and other whale oil, and cod, seal, shark, porpoise, and dolphin oils. The fluid vegetable oils may be divided into two classes: drying oils, or those which take up OXYGEN from the air and become dry and hard when thinly smeared over anything; and non-drying oils, or those which do not thus become dry. The principal drying oils are linseed, walnut, poppy, and hemp. They are largely used to mix with paints, which would not dry if they were mixed with non-drying oils. The non-drying oils are greasy and turn rancid, that is, spoil, instead of drying, when used in the same way as drying oils. The principal ones are olive, almond, colza (made from the seeds of a kind of cabbage which grows in France and Belgium), peanut, cotton-seed, and mustard-seed oils. Castor oil will dry, but not until after a long time.

Oils are made up of CARBON, OXYGEN, and HYDROGEN, mixed in different proportions. When pure they are without smell or taste, but they usually contain a little of certain ACIDS which give them an odor. They are generally light yellow, but may be bleached white by leaving them in the light. None of them will mix with water, but they will dissolve in ether and turpentine, and generally in alcohol. The fixed oils may be separated into three things, two of which, *stearine* (from Greek *stear*, tallow) and *palmitine*, are solid at common heat, and the third, *oleine* (from Latin *oleum*, oil), is liquid. Beef tallow is mostly stearine; butter and olive oil, oleine and palmitine. The uses of the oils and fats are numerous and important; soaps, candles, paints, ointments, and other things are made from them, and they are used for food and medicine, for greasing machinery, for burning in lamps and stoves, for making gas, for dressing leather, and many other purposes.

Essential Oils are like the fixed oils in some things: they will burn, are lighter than water, will not mix with water, and will mix with ether and with alcohol; but they are unlike them in passing off into

the air in the form of vapor at common heats, and in not leaving a greasy stain on paper after drying. They are got from plants by distilling with water the flowers, wood, or other part of the plant which contains the oil. The vapor of the oil mixed with the vapor or steam of the water passes over into the condenser, where all the vapors are cooled, and the oil settles and floats on the top of the water. Essential oils must be kept in close vessels or they will pass off as vapor. They are largely used in the arts, especially in the making of PERFUMES, the flavoring of confectionery and of liqueurs, and in medicine. The oil of turpentine, an essential oil distilled from common TURPENTINE, is very valuable because it will dissolve the RESINS and India-rubber. It is largely used in making varnishes. Other principal essential oils are made from various gums, resins, and spices, and from the seeds, fruits, flowers, leaves, bark, and other parts of plants.

The word oil is from the Latin *oleum*, Greek *elaion*, oil.

OIL-CLOTH, a covering for floors made of painted canvas. In this country it is usually called oil-cloth, but in England floor-cloth. The canvas, which used to be made of hemp, is now generally a kind of JUTE cloth called burlaps, made in Scotland. It comes in limp strips two yards wide and twenty-five feet long, and has first to be stiffened. This is done by passing it through a mixture of starch and glue and then over hot rollers which dry it, when it is ready for painting. There are four qualities of oil-cloth: the best kind has five or six coats of paint put on it before printing, the poorer kinds a less number. Each coat requires twenty-four hours to dry, so it takes a week to paint the best quality. The paint is put on by a machine which has a steel knife to regulate the thickness. Three men working one machine can paint a hundred pieces in a day. All the coatings of paint are of one color, like that seen on the underside of oil-cloths, and they are put on both sides alike.

When dry the cloth is sent to the rubbing machine, where the side to be printed is rubbed with glue and sand until perfectly smooth, when it is ready to have the pattern printed. This is done usually in another room on a long flat table. The printing is done by means of wooden blocks in much the same way in which CALICOES are printed by hand. The blocks, which come from Maine, are of maple, about two inches thick and two feet square. Each block has a part of the pattern cut on its under side, and there is a separate block for every color. For example, if the oil cloth is to have black, white, and green in it, the block which prints the black part of the pattern will be stamped on first, it being moved along from place to place until the whole surface has been covered. After this is dry the white will be put on in the same way, and when that is dry the green will be stamped on. If there is to be a border on the cloth a space is left bare for it, and it is afterward put on with small blocks.

Some patterns containing many colors require 25 to 30 blocks. After printing the oil-cloth is thoroughly dried and finally varnished and trimmed, when it is ready to be shipped.

OKRA, an annual which probably first grew in Africa, but is now found in all the warm parts of America. It is called also ochro, and sometimes gombo or gumbo, though this name is generally given only to a kind of soup made of the pods, which are full of mucilage. The young pods are sometimes cooked like asparagus, and sometimes pickled like cucumbers, for winter use. Okra has a long and strong fibre, well adapted for making rope, twine, and sacking, and in France it is made into excellent paper.

The word okra is supposed to be West Indian.

OLEOMARGARINE, artificial butter made from tallow. The solid fat of cattle is cleaned of flesh and other impurities and, after being thoroughly washed in cold water, is heated until liquid. It is then mixed with fresh milk and some coloring matter, generally annotto, and churned. It collects like butter, and is then washed, salted, and packed like natural butter. The imitation is so good that it is difficult to tell it from real butter, for which it is often sold, although there is a law against it.

Oleomargarine is from Latin *oleum*, oil, and margarine (Latin *margarita*, a pearl), a name given to a pearl-like substance made from hog's lard.

OLIVE, the fruit of an evergreen tree which belongs to the same family with the lilac, the ash, and others. The tree, which grows about four times as high as a man, is supposed to have first come from Western Asia. The ancient Egyptians cultivated it and its branches or leaves have been found in mummy-cases. The Greeks, who knew it early, used the oil for annointing their bodies; but the Romans did not have the tree until about the seventh century B. C. The olive is now largely cultivated all around the Mediterranean. Many are grown also in South America, Mexico, and California. Its leaves are much like those of the willow, and are dull green above and whitish beneath; and its flowers, which are small and white, grow in clusters. The wood is greenish yellow with dark spots and veins, and fine grained, and is much used by cabinet makers and turners for fine work; and the wood of the roots is made into small boxes and ornaments. There are several kinds of olive trees, the fruit of which varies in size from that of a cherry to a pigeon's egg. Olives are either pickled or made into oil, being too bitter to eat as fruit. Those to be pickled are picked when green and soaked in strong lye (see ASHES) or lime water, which makes them softer and milder in taste; they are then soaked in water for several days, the water being changed often, and are finally put into jars or bottles, covered with strong brine seasoned with cloves, cinnamon, and other spices, and sealed up. A common kind are often packed in small wooden kegs.

Olive Oil is made from the ripe fruit, which is ground to a pulp, put into coarse bags and pressed; the oil runs into a cistern of water, on the top of which it floats, and from which it is dipped out. After the first pressing, the pulp is wet with boiling water and pressed again, but the oil thus made is of poorer quality than the first. Olives which have just began to ripen make the best oil, which is of a slightly greenish color, but those fully ripe make the most oil. In Europe olive oil is largely used in cooking and is eaten instead of butter, but in this country is chiefly used for dressing salads. Much is made, in the countries where olives are raised, into Castile and other soaps; and in Italy a cheap oil, made from small olives, is much used for burning in lamps. A kind of resin, which is found on the trunks of old olive trees, smells like vanilla, and is used in Italy for perfumery.

The word olive is from the Latin *oliva*, Greek *elaia*, the olive tree.

ONION, the common name of a kind of plant which includes also the GARLIC, leek, shallot, and chives. The onion first came from western Asia, but is now cultivated almost all over the world. Many were grown in ancient Egypt, and in the paintings in temples onions are often shown held in the hands of priests. The plant is raised usually from the seed; it produces a bulb the first year, and if this bulb be planted the second year, a flower stalk will sprout from it which will bear seed. Potato or ground onions

do not bear seed, but form many small bulbs underground; and top or tree onions bear, instead of seed, a cluster of little onions on the top of a stalk. Onions are much used, both raw and cooked, for food, and also as a seasoning for soups and other dishes. They are easily digested and are very healthful. In Spain and Portugal a raw onion is often eaten like an apple, or sliced and eaten on bread. Onions are used in medicine like garlic. They are brought to our markets chiefly from the Bermudas and the New England States.

The **Leek** has no bulb, but the stem thickens at the bottom something like one. Its flavor is milder than that of the onion. It is much used in cooking, especially by the Welsh.

The word leek is from the Anglo-Saxon *ledc*, leek.

The **Shallot** is a small onion with many bulbs, with a flavor something like that of garlic, but milder. Its bulbs are used like onions, and its leaves like chives.

The word shallot is rightly eschalot, Spanish *escalona*, which is from Ascalon, a town in Palestine, from which it was first brought to Europe by the Crusaders.

Chives, or cives, are a kind of small onions, with flat bulbs growing in clusters. The leaves are used for flavoring soups and other dishes.

The word chives is from the French *cive*, which is from the Latin *cepa*, an onion.

The word onion is from the Latin *unio*, a large kind of onion, named from *unus*, one, because its bulb was made up of a single piece.

ONYX. See AGATE.

OPAL, a mineral much like quartz, but more beautiful. Precious or noble opal is bluish or yellowish white, and has a fine play of bright colors in it, like the colors of the rainbow. It is much valued for setting in rings, brooches, and other ornaments. The finest opal comes from Hungary, but some is brought from Honduras, Mexico, and Queensland, Australia. Fine opal is found in the United States in Oregon, Washington, Colorado, and California. Opals for jewels are always cut with a round surface, which shows their colors best. Common opal is of various colors, white, yellow, red, brown, or green, and has no play of colors. It is cut into slabs and made into boxes and ornamental articles.

The word opal is from the Latin *opalus*, Greek *opallios*, the opal.

OPIUM, a drug, the dried juice of the white poppy. The poppy grows wild in India, Persia, and other parts of Asia. In Europe and America it is cultivated as a garden flower, but in India, Persia, Asia Minor, Arabia, and Egypt, it is largely grown for its opium. A few days after the flowers have fallen men go through the poppy fields in the afternoon and make little cuts in the poppy heads; a milky juice oozes out and dries into a soft brown sticky paste; each morning this paste is scraped off and put into jars, and is afterward made into balls of about a half pound each and packed into chests to be sent to foreign countries. The most opium is raised in India and sent thence to China, where it is largely used for smoking with tobacco; but in India it is eaten, not smoked. The opium brought to the United States comes chiefly from Smyrna. With us it is used mostly as a medicine in the form of laudanum and paregoric. Laudanum is simply opium dissolved in alcohol; paregoric is made up of opium, camphor, honey, alcohol, and other things. The value of opium lies in its power of quieting the nerves and taking away pain; but if too much is taken it puts one into so deep a sleep that one never awakes from it.

The word opium is from the Latin *opium*, Greek *opion*, poppy-juice.

OPOSSUM. There are several kinds of opossums, none of which live anywhere but in America. The common Virginia opossum, which is

found all over the United States, is about as large as a cat, but is shaped more like a rat. It has short legs, a long smooth tail covered with scales instead of hair, and a sharp rat-like nose. Its fur is a thick coat of light gray wool, with long hairs sticking out of it, and its ears, nose, feet, and tail are almost black. Underneath the female is a kind of pouch or bag, in which she carries her young for about five weeks after they are born. At the end of that time the little ones leave the pouch, but they often go back into it to suck or when they are frightened, until they are about two months old, when they are large enough to take care of themselves.

The opossum spends the day mostly in hiding among the leaves, in hollow trees or logs, and in holes in the ground, or swinging from limb to limb by means of its tail.

It may often be seen hanging by the tail or by one or more of its feet, eating wild grapes or persimmons, or robbing birds' nests. In the night it usually prowls around looking for food. It lives chiefly on nuts, berries, and tender twigs and roots, but eats also insects, worms, birds, mice, and other small animals. It never digs in the ground, but builds its nest in the hollows or logs, and in holes at the roots of trees. Into these it will carry leaves and make itself a bed when bad weather is coming on. Opossums get very fat in the autumn, and are then much prized for food in the Southern States, especially by the negroes, who take great delight in hunting them; but dogs will not eat them. Their flesh when cooked is much like roast pig. When attacked the opossum looks very fierce, snarls, growls, and will often bite, but if struck will make believe to be dead and will not stir even if it is hurt; but it will watch slyly and crawl away as soon as its enemy is gone. From this comes our phrase "to play 'possum."

Surinam Opossum.

The other kinds of opossums are found chiefly in South America. Among the most cunning of all is one which lives in Surinam. The young ones hang fast to the nipples or teats of the mother until they are

able to run around, and then they are carried on her back, where they cling fast to her wool and hold themselves by coiling their tails round hers, as shown in the picture.

The opossum is a MAMMAL of the order *marsupialia*, or pouch-bearing animals, to which the KANGAROO also belongs.

The word opossum is from *opassom*, the Indian name of this animal.

ORANGE, the fruit of a tree belonging to the same family with the LEMON, lime, CITRON, and SHADDOCK. Some think that there are four or five different kinds of oranges, and some that there is only one kind, which has become changed into several varieties by climate and cultivation. The bitter or sour orange tree was first brought from India, where it grows wild, and was carried into Europe first about the eleventh century through Arabia. The sweet orange came probably from China or Cochin China; it was carried about the time of Christ to India, and spread thence westward into Europe, where it was not cultivated much before the fifteenth century.

The orange tree grows about as large as a small apple tree. It blooms but once a year, bearing a great number of beautiful, fragrant, white flowers, in clusters, with which brides are crowned and decorated. The fruit ripens generally in about six months after blossoming. Oranges to be sent to foreign countries are picked when fully grown but while yet green, and are not so good as those which ripen on the trees. In some countries those intended to be eaten at home are allowed to hang all winter on the tree, and sometimes until the next summer.

The orange tree and its fruit have many uses. The wood is hard and close-grained, and is used by turners and joiners, and for making canes. The leaves, flowers, and rind of the fruit are full of fragrant oils, which are used in making COLOGNE and other perfumes. Orange flower water is used by druggists to flavor mixtures, and by cooks to flavor dishes. The fruit of the sweet orange is highly esteemed for eating, and that of the bitter orange for making MARMALADE. Orange peel is candied and used in flavoring puddings and other things.

The oranges used in the United States are brought chiefly from Florida, California, Sicily, Malta, Spain, and the West Indies. Those from Europe are generally smooth and thin-skinned, and come rolled up in thin white paper. The West India fruit is rougher skinned and sweeter, and comes in bulk, that is, all packed together without any wrappers. Malta oranges are called blood oranges, because they have a crimson pulp. The mandarin orange is a small orange flattened at the top. It was originally from China, but is now raised in Algeria, Brazil, and other places.

The cultivation of the orange is now a very important business in Florida and California, and the best oranges in the eastern markets come from those States. Many different kinds are cultivated. Among the largest and handsomest is the navel, first brought from Bahia, Brazil, in 1870, which is nearly seedless. It ripens in California in December and January. The Mediterranean sweet, a fine juicy fruit almost as large, is later, often ripening in May and June. The Maltese blood orange, the Rio, the paper rind, and the St. Michael, the last named from the Azores, are all popular fruits. The mandarin and the tangarine, the latter a rich reddish flat orange with a thin skin, and many other kinds, from all parts of the world, are also cultivated.

The picking season in California is very gay. The pickers, Mexicans, Americans, and Chinese, men and boys, take possession of a grove under an overseer. Two or three are

appointed to a tree, each furnished with a long step-ladder to enable him to reach the topmost branches. Each orange is carefully cut from the tree, for if the skin is broken it will soon decay, and put into a bag worn around the neck. When a bag is filled it is handed to the washer, generally a Chinaman, who washes the black stain or rust from the fruit, and polishes it with a cloth. The oranges are then assorted into different sizes, each size wrapped in its proper color of tissue paper, and packed into boxes for market.

The word orange is from the Arabic *nâranj*, the orange tree.

ORANG-OUTANG. See APE.

ORCHESTRA. In modern theatres the orchestra is the place in front of the stage where the musicians sit; but the name is more commonly given to a band of musicians who use mostly stringed instruments. A body of musicians using mostly wind instruments is commonly called a band.

A grand orchestra is made up of not less than sixty musicians, and often of more than a hundred. Three kinds of instruments are commonly used: 1. Stringed instruments, made up of first VIOLINS, second violins, violas, violoncellos, and double basses; 2. Wind instruments, made up of FLUTES, HAUTBOYS, CLARINETS, BASSOONS, HORNS, TRUMPETS, and TROMBONES; 3. Beaten instruments, such as kettle-DRUMS, CYMBALS, and TRIANGLES. There are always many more stringed instruments than wind instruments, and usually but few beaten instruments. In modern music other instruments, such as the HARP, PIANOFORTE, ORGAN, bells, and bass and snare DRUMS, are sometimes added. In a military band only wind and beaten instruments are used.

The word orchestra is Greek. The orchestra in Greek theatres was a part of the stage where the chorus danced; and the word is from *orchesthai*, to dance.

ORCHID, a plant of the orchis family. Orchids are perennial herbs (see PLANTS), some, in cool climates, growing in the ground, and others, in hot climates, growing on the branches of trees. The leaves differ greatly, some being thin and others thick and fleshy, some very broad and some long and thin like a whip-lash. The flowers, too, are unlike those of other plants, and are noted, some for their beauty, some for their fragrance, and some for their singular forms. One kind bears flowers that look like a butterfly, another like a spider, and others closely resemble other insects. There are about 5000 kinds of orchids, distributed all over the world, excepting where it is very dry or very cold. Some grow in Northern British America and others throughout the United States, all being earth orchids except two kinds in Florida that grow on trees. The VANILLA plant of Mexico, Central and South America, is an orchid. Orchids are much cultivated by wealthy people, and large sums have been paid for rare varieties.

The word orchid is from the Greek *orchis*, a bulb, referring to the shape of the root.

ORGAN. When we look at a church organ from the outside we see only a row of pipes of different sizes above, and several key-boards, each one much like the key-board of a piano, below; and we are led to wonder how so few pipes can make so much noise, and why so many key-boards, all just alike, are needed to play them. But if we go inside of an organ, we see why this is.

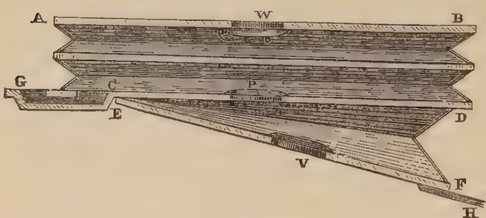
An organ is really a great room, filled with hundreds, and sometimes with thousands, of pipes of many different kinds and shapes, but all so arranged that one can easily walk in and look at them. The pipes are usually put up in four different groups or sets, each having a different key-board, so that a church organ is really

four organs in one. The set of pipes in the front part, to which those seen from the outside belong, is called the great organ, which is played more than any other part of the organ. Behind it is another group of pipes making up the choir organ, whose tones are not so strong, and which is chiefly used to sing with. Above the choir organ is a box full of pipes called the swell organ. This box is closed on three sides, but has blinds in front, which the organist can open and shut by pressing a board called a pedal with his foot. When the blinds are shut the sound of the organ is muffled and seems to be far away, but when open it comes out loud and full. Each of these organs is played by its own set of keys in a separate key-board placed one above the other like stairs. Each set of keys is called a manual (Latin *manus*, the hand), because played by the hand. The lower one is the choir organ manual, the middle one the great organ manual, and the upper one the swell organ manual.

The fourth group of pipes inside the organ is called the pedal organ, because it is played by pedals (Latin *pes*, *pedis*, a foot), which are large keys moved by the feet. The pedals are placed in a row under the manuals, where the organist can easily reach them with his feet while playing with his hands above. The pipes of the pedal organ are sometimes set up in a group behind the choir organ, and sometimes it is divided into two parts, one being set on each side. Any one of the four organs may be played separately, or two or three of them may be played together.

The sounds of the organ are made in the pipes by wind, which is collected in a bellows and carried to the different parts by machinery worked by the organist. We may divide the working part therefore into three parts: 1, the bellows: 2, the machinery which carries the air to the pipes; 3, the pipes.

1. **Bellows.** There are several kinds, but the one in the picture is the most common one in use. It is called the double bellows because it is in two parts. It has in it three boards, one on top, A B, one in the middle, C D, and one at the bottom, E F. The part between A B and C D makes the upper part of the bellows, called the riser, because it goes up and down, and the part between C D and E F the lower part, called the feeder, because it feeds the riser with air. The small parts marked W, P, and V are VALVES, or little doors opening through the three boards. All the parts between the boards are of leather, so made that they will fold flat together when the boards are brought near to each other, and which will open, as shown in the picture, when the boards are apart. The bellows are worked by the handle, H, of which only a part is seen. Now, suppose that the handle H is moved up until the board E F is flat against the board C D. There is then no air in the feeder; but if the handle be next pressed down so as to be like the one in the picture the pressure of the outside air will open the valve V and the air will rush in and fill it. If now the handle be pulled up towards D again, the air in the feeder will be pressed tight between the



Organ Bellows.

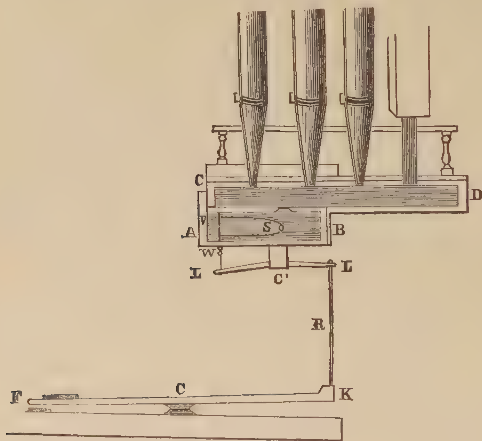
two boards. This will shut the valve V so that the air cannot get out that way, but will force open the valve P, and all the air will rush into the riser. Thus, each time the handle is pushed down, air rushes into the feeder through the valve V, and each time the handle is pulled up, the same air rushes out of the feeder through the valve P into the riser. On top of the riser are kept some heavy weights which are all the time pressing it down. This forces the air out of it, through the box G, into a pipe called the wind-trunk, which leads to the wind-chest, which will be told about soon. The valve W on the top of the riser is called the waste valve, because when the bellows are full enough it lets out or wastes some of the air. In small organs one bellows usually gives air to the whole organ, but in some organs each part has its own bellows and very large organs have sometimes ten or twelve bellows. Sometimes the bellows is worked by a man called the organ-blower, but in large organs, where there are many bellows, they are moved by steam or water-power. In large organs, too, the bellows are often arranged differently, but as they are hard to understand, only a simple one is told about here.

2. The **Machinery** which carries the air to the pipes is made up of the wind-trunks, the wind-chest, and the sound-boards. The wind-trunks are tubes to carry the air from the bellows to the wind-chests, from which the pipes are filled. Each one of the organs in a church organ has its own wind-chest; that is, the great organ, the choir organ, the swell organ, and the pedal organ have each one, from which all the pipes of each get their wind. The wind-chest is a long box fitted to the under part of the sound-board. The sound-board is wrongly named, for only the pipes make any sound. It is really a long low box, about twice as wide as the wind-chest, divided up by thin boards, running from the front to the back into as many narrow boxes as there are keys in the key-board. The wind-chest is fastened under the front part of the sound-board, and in its top is a row of valves, like long slat doors, each one opening into one of the narrow boxes of the sound-board. In the picture only one end of the wind-chest and one end of the narrow boxes of the sound-board are shown. In this A B is the wind-chest, C D is the sound-board, and V is one of the valves opening from the wind-chest into one of the boxes of the sound-board.

The top of the sound-board, which is made of thick, strong board, is something like a chess-board, into each square of which is set the end of a pipe. The pipes of the organ are therefore in rows, which run both ways, from front to back, and from right to left, just like the squares of the chess-board. Each row of pipes running from front to back opens into one of the narrow boxes of the sound-board; and each row of pipes running from right to left has a slide fitted to the under side of the top of the sound-board, with as many holes in it as there are pipes in the row, and so made that, when it is pushed in, the holes are shoved beyond the ends of the pipes in that row so that the wind cannot get into them, and when it is pulled out, the holes are brought under the pipes so that the air can rush into all of them. All the slides run crosswise of the narrow boxes so that when one is pushed in, the hole of one pipe opening into each box is closed. If there were no slides to open and close the pipes, every pipe in a row running from front to back would sound when wind was let into the narrow box under them; but by means of the slides the organist can sound any he wishes. On the front of the organ, near the key-board, are several rows of small knobs, made to draw out and push in. These, which are called stops, run back into the organ and

move the slides told about above. Every organ has as many stops as it has rows of pipes running from right to left. When all the stops are pushed in, all the rows of pipes are closed, and no pipe will sound no matter how much wind is let into the boxes from the wind-chest. The first thing an organist does, therefore, when he sits down to play, is to pull out one or more of the stops. The different rows of pipes which the stops open and close, have different tones, and are named usually from something which they are thought to sound like: thus there are the OBOE stop, the TRUMPET stop, the BASSOON stop, the FLUTE stop, the *vox humana* (Latin, human voice) stop, and many others. When only one stop is drawn out, the keys will play only on the pipes of the kind which make up that stop; but two or more may be drawn out and played at the same time so as to make mixed tones. In some large organs there are fifty to one hundred stops.

If you now look at the second picture again you will see how the machinery which lets the wind into the pipes works. In this only four pipes are shown opening into one of the narrow boxes of the sound-board, but some organs have many more.



Side View of Organ.

When the bellows of the organ is worked, the wind is forced through the wind-trunk into the wind-chest until it is filled full of air, packed so closely that it is much denser or thicker than common air. At the bottom of the picture, on the left side, one of the keys of the organ is shown at F. The key is really a long stick running back to K, and so hung at C that it can move up and down. To the end of K is fastened a stick R, named a sticker, the other end of which is made fast to another piece L L, so fastened at C′ that it can move up and down. To the other end of L is fastened a wire W, which passes up through a hole in the bottom of the wind-chest and is made fast to the valve V. If you press down the key F with your finger, the other end, K, will push up the sticker; the sticker will push up the right-hand end of L, which will bring down the left end, and this will pull the wire W and open the valve, letting the wind into one of the boxes of the sound-board, shown at C D. If all the slides which run under the four pipes in the picture are closed, none of the pipes will sound, and if all are open, all of them will sound; as said before, the organist can open as many as he pleases by pulling out stops. Thus, when the keys are pressed down, the valves of the wind-chest open and let the wind into the different boxes of the sound-board, and those pipes sound whose slides have been opened by the stops. No pipe can sound until the drawing out of a stop opens the holes in the bottoms of the pipes, and the strik-

ing of a key lets the wind rush in under the pipes. Each stop has one pipe over each box of the sound-board, and each key opens and lets the air into one of the boxes.

3. The **Pipes** of an organ are generally of two kinds: flue pipes and reed pipes. Those usually seen in the front of an organ are flue pipes. Some flue pipes are made of metal and some of wood.

Flue Pipe.

Metal ones are usually round, and wooden ones square, like the right-hand one in the second picture. A metal flue pipe is made like the one in the third picture. In this *b* is the body and *a* is the foot; *c* is a flat plate of metal, called the language, which reaches nearly across the pipe to the opening *d e*. When the wind is let in at the bottom of the foot, it rushes through the narrow slit at *d*, and in striking against *e* sets trembling the column of air in the body *b*, and thus makes a musical note. Wooden flue pipes are a little different, but they work in much the same way.

Reed Pipe.

Some flue pipes are stopped up at the top, and others have a kind of chimney on them. Reed pipes are also made of both wood and metal. They have a kind of mouth-piece called a reed, somewhat like that of a CLARINET, fitted into a block inside the pipe. The wind, which is let in at the bottom in the same way as in the flue pipe, rushes up through the reed and causes a thin plate of metal called the tongue to tremble and make a musical note. One kind of reed is shown in the fourth picture. In this *b* is the block in the pipe, and *r* is the reed passing through it; *t* is the thin metal tongue, and *s* is a wire by which the tongue may be made shorter or longer.

Organ pipes are of many different sizes, some being no larger than a child's whistle, while others are more than five times as long as a man, and large enough round for a boy to crawl through. The largest organ in the world is in the Albert Hall, London. It has 138 stops and nearly 10,000 pipes, all of metal. The largest one in America, in the Music Hall, Boston, has 89 stops and 4000 pipes.

The word organ is from the Latin *organum*, Greek *organon*, an instrument.

ORIOLE. See BALTIMORE BIRD.

ORRIS ROOT, the root of a kind of iris or flag plant, belonging to the same family with SWEET FLAG. It grows wild in the south of Europe. The root, which smells like violets, is ground up and used to scent tooth powder, hair powder, violet powder, and hair oils. It is also distilled (see ALCOHOL) and made into a perfume called essence of violets, though it has no violets in it.

The word orris is merely a wrong form of *iris*, the Greek name of the plant.

OSAGE ORANGE, an American tree growing chiefly in Arkansas and the States near it. It belongs to the same family with the mulberry, is a spreading tree with handsome dark green shining leaves, thorny branches, and bears a fruit that looks much like a warty green orange. The tree grows 30 to 60 feet high, and sometimes two feet thick. Its wood is hard, strong, and elastic, the centre being orange shading into brown, the outer part lighter yellow. The Indians made their bows of it, from which the French called it *bois d'arc* (bow-wood), a name now corrupted into bodark or bodock, by which it is known in the West. The wood is used also for making wheels and for ornamental work. The fruit, which becomes yellowish when ripe, is not good to eat. In the West the Osage orange is much used for making hedges, on account of its thorns

and its freedom from disease and insects.

The Osage orange is so called because it was first found in the country of the Osage Indians, on the Arkansas River.

OSTRICH. The ostrich is the largest of living birds, being often eight feet high, or two feet taller than a man. It is found chiefly in the barren sandy plains of Africa,

African Ostrich.

but a few are sometimes seen in Arabia and other parts of Asia. The ancients used to call it the camel-bird, because, like the camel, it lives in arid deserts, feeds on the coarsest herbage, and can go a long time without water. The males are usually glossy black, with the exception of the loose feathers of the wings and tail, which are white. These white feathers are the ones used by ladies for hat plumes. The females and young birds are brownish-gray. The head and neck are nearly bare, and the feathers of the body are not close like those of other birds, but so loose that the air can pass freely through them, while at the same time they shade the body from the sun. The eyesight and hearing of ostriches are very sharp, and as these birds are also very swift, they are hard to catch. They cannot fly, but use their wings in running, and sometimes go at the rate of thirty miles an hour.

Ostriches live chiefly on fruits, grain, leaves, tender shoots, snails, and insects. They swallow a good many stones to grind their food with, and have been known to gulp down pieces of iron, glass, leather, and other hard things. An ostrich kept in a menagerie once swallowed some copper coins and a piece of a parasol handle, but these were too much for its stomach and it died. They are generally called stupid birds, and the Arabs have a proverb, "As stupid as an ostrich." It is said that when one of them is hard pressed by the hunter it will thrust its head into a bush or into the sand, and imagine that it cannot be seen, because it cannot see. In South Africa the Bushmen cover their bodies with the skin of an ostrich, and by acting like one get near enough to the foolish birds to shoot them with poisoned arrows. It is said also that ostriches will not step over anything more than a few inches high, notwithstanding their legs are so long, and that they may be shut in by a very low fence. But some travellers say that the stories told about the ostrich's stupidity are slanders, that it is really a shrewd bird, very watchful in guarding against its enemies and very careful in raising its young.

It is said that the ostrich will bear a man on its back, and that in some parts of Africa people ride on them more swiftly than we ride on horseback. In the zoölogical garden in the Bois de Boulogne, Paris, are some fine ostriches which are often harnessed to light carriages, in which children ride about the ground. A man always goes along beside the bird, for fear that it may take it into its head to start off on a run at the rate of thirty miles an hour, as it does in its desert home.

Many ostriches are now kept on

farms at the Cape of Good Hope for the sake of their feathers. The fields in which they are kept are sowed with grass, and this forms their chief food. When the female gets ready to lay she and the male scrape a large hole in the sand, and in this fifteen or twenty eggs are laid. An ostrich egg is very large and holds as much as twenty-four hen's eggs. The Bushmen use the shells for water vessels. The male bird sits by night, the female in the morning and evening, the nest being often left uncovered during the heat of the day. The ostrich chick, for the first two or three weeks of its life, looks like a little hedgehog on two legs, with a long neck. Instead of feathers it has a rough coat which seems to be made up of narrow strips of different shades of brown and gray, mixed with shreds of black; while its head and neck are covered with the softest plush marked like a tiger's skin. It has large bulbous eyes and walks with an air of conceit which is very amusing. The feathers of the young ostriches are first plucked when they are about eight months old, though they are not then good for much, and they are afterward plucked every eight months. Ostrich feathers are largely used for plumes, for trimming dresses, and for other ornamental purposes. White ones are scoured with soap and bleached. Black ones are white ones dyed with LOGWOOD and copperas.

There are ostrich farms also in California, in San Diego and Los Angeles counties. The first birds were brought from South Africa, but many are now hatched and raised on the farms, chiefly by artificial heat. If the eggs are taken from the nest as they are laid, the ostrich will lay as many as forty eggs, so more are got in this way than if the birds were allowed to sit and raise their own broods. In California the feathers are not plucked but cut. The birds are driven one by one into a kind of box which opens at each end. When in this the feathers are clipped off with shears, and the bird is then let out at the other end into another enclosure. The quills thus left in fall out in time, when new feathers grow. Each bird is said to furnish about $100 worth of feathers.

The **American Ostrich**, or **Rhea**, found in South America, differs somewhat from the real ostrich, though in its general shape it is much like it. It is only about half as large, has no tail feathers, and has three toes, while the African ostrich has only two. The cock bird makes the nest, hatches the eggs, and takes care of the young. The American ostrich is sometimes called the *nandu*. These birds are very swift, and run in zigzag lines so as to tire out a horse, but they are sometimes caught by several horsemen who ride them down and catch them with the lasso or the bolas (see HORSE). Their feathers are not so valuable as those of the African ostrich, and are used chiefly for making feather brushes. In Patagonia the Indians make beautiful rugs out of the whole skin, after pulling out the long wing-feathers.

American Ostrich.

The ostrich belongs to the order *cursores*, or running BIRDS.

Our word ostrich is made from the Latin words *avis*, bird, and *struthio*, ostrich. The Spaniards still call it *avestruz*, which is much nearer the Latin than our name.

OTTER. This animal is larger than others of the weasel family, to which it belongs, being often four feet long, and differs from them in living mostly in the water. Its paws are webbed for swimming, and its food is chiefly fish. Its fur is short, thick, fine, and quite handsome. In summer it is almost black, but in winter it turns to a beautiful reddish brown. Otters take as much delight in sliding down hill as boys do, and may be seen going one after another down hills of mud and snow. They are found in almost all parts of the world, and the different kinds are very much alike. The American otter is plentiful in British America, where thousands are killed every year for their furs.

The **Sea Otter,** found along the north Pacific coast of America, is much like the seal, with a head somewhat like that of a cat. It feeds on fish, crabs, shell-fish, and sea plants. Sea otters live in couples. The female has but a single young one at a time, and she takes the most tender care of it. A mother otter may often be seen playing with her little one on the ice and in the water. She frequently sleeps on top of the water, with her back downward and holding her baby in her fore paws. Hunters often kill them when thus asleep for their fur, which is much prized in China and Russia. In China mandarins of high rank wear otter fur as a mark of office.

The otter is a MAMMAL of the order *carnivora*, or flesh-eating animals.

The word otter is from the Anglo-Saxon *otor*, otter.

OWL. The owl has a short, stout form, downy feathers, and a large head with a flat face. The eyes are round and staring, and have a fringe of stiff feathers around them; the bill is short, strong, and hooked; and the ears are very large and pointed forward. Some owls have tufts of feathers on the head which stand up like horns, from which they get the name of horned owls. During the daytime owls hide away in holes in trees, in caves, and in old buildings; but in the dusk of the evening, when they see better than in broad daylight, they fly around looking for game. They live mostly on rats, mice, moles, squirrels, and other small quadrupeds, and on other birds, and some of the smaller kinds eat moths, beetles, and other insects. They catch their prey with their claws and not with their beaks; if it is small they swallow it whole at one gulp, the bones and hair or feathers being afterward vomited up in a ball or wad, but if large they first tear it into pieces.

When by chance an owl comes out of its hiding place in the daytime, the little birds often attack it in flocks, and try to revenge themselves on their enemy, who kills so many of them by night. When thus attacked the owl ruffles up its feathers, wags its head with a stupid look, and shows its anger by snapping its bill; but as it cannot see well enough to fight it has to bear the blows and pecks of its persecutors as well as it can. In ancient times hunters used to take advantage of this to catch little birds. After covering the twigs, bushes, and trees with a kind of sticky glue called birdlime, the hunter would make a noise like the cry of an owl, and the birds, flocking together to fight their enemy, would perch on the twigs and get stuck fast, so that they were easily caught.

Owls are found in almost all parts of the world, but many of those in other countries differ from those living in the United States, where there are about forty kinds. Among the commonest American owls are the following:

The **Barn Owl,** whose feathers are grayish brown mixed with yellow, white, and dark brown. It has no

real cry, but makes a kind of hissing sound. The barn owl of Europe is much like it, but makes a kind of screech, from which it is sometimes called the screech owl. Barn owls are often looked upon as birds of ill omen, and some people are silly enough to believe that when one appears it is a sign of death in the family. Such fears are foolish, for these birds are very harmless and useful, as they kill rats and mice and other vermin hurtful to gardens and crops. The barn owl is very brave: a pair of them have been known to kill a cat which had attacked their nest.

The **Great Horned Owl** is found almost all over North America. It is about two feet high, and has on its head two feathery tufts standing up like horns, from which it gets its name. It makes many singular noises, sometimes barking like a dog, sometimes coughing like a person choking, and sometimes breaking out into a wild yell like "Waugh O! waugh O!"

The **Little Horned Owl**, found throughout the Northern States and Canada, is called also the American screech owl, the red owl, and the mottled owl. It is a pert little fellow, not more than ten inches high, with staring eyes and feather-tufts like ears. It is sometimes seen in winter in city parks, where it is drawn probably by the sparrows, on which it feeds.

The **Barred Owl** is common in the Southern States. It is about twenty inches high, has a large head but rather small eyes, and no ear-tufts. It is a queer bird and has odd habits. Its cry is a kind of laugh, like "Whah! whah! whah-a-a-aa!" and it may often be heard in the thick woods in the middle of the day.

The **Burrowing Owl** of the western plains is so called because it lives in burrows or holes in the ground. In India there is a kind of owl which digs its burrows, but the burrowing owl of this country lives in holes which the prairie dogs have left. Most of the stories told about their sharing the same hole with the prairie dog and the rattlesnake are untrue. These owls prowl around in the daytime, feeding on grasshoppers, crickets, and field mice.

In ancient times the owl was thought to be a very wise bird, and the Greeks made it the emblem of wisdom and sacred to Minerva, the goddess of wisdom.

The Chinese and the Tartars also hold it in great respect, because Genghis Khan, the founder of their empire, was once saved by an owl. After losing a battle he was forced to flee from his enemies and hide himself in a wood. An owl perched in the very thicket where he was lying, and his pursuers, thinking that the owl would have been frightened away if he had gone in there, did not search that place, and so passed him by. For a long time the Chinese used to wear an owl's feather in their hats, and some Tartar tribes still worship idols made like owls.

The owl belongs to the order *raptores*, or BIRDS of prey.

The word owl is from the Anglo-Saxon *ule*, which is from the Latin *ulula*, an owl. The Romans called the owl by this name probably from the sound of its voice, *ululare* meaning to howl.

OXYGEN, the most abundant of the ELEMENTS. At least one-third of the solid part of the earth, one-fifth of the AIR, and eight-ninths of all the WATER on the globe are composed of it. All minerals are one-half, all animals three-quarters, and all vegetables at least four-fifths oxygen by weight.

Oxygen in its usual form is a GAS which, like air, has neither color, taste, nor smell; but it may be changed into a liquid by a great amount of cold and pressure. It is a little heavier than air, and sixteen times heavier than HYDROGEN. It is not only the most abundant substance in the world; it is also one of

the most important of all things. We breathe it in with the air, and it is the food of the LUNGS, just as the food which we eat is the food of the stomach. We could live for several days without eating, but we should die very much sooner if our lung food were taken away. Under certain conditions oxygen takes a condensed form called ozone, which is one and a half times as strong as oxygen. There is more ozone in country air than in the air of towns, and it is therefore stronger and more healthful. In crowded places in cities there is scarcely any ozone.

The most important thing about oxygen is that it will unite with all the other elements but one (fluorine). When HYDROGEN, CARBON, SULPHUR, SODIUM, and IRON, for example, are brought into contact with oxygen at a proper degree of heat, they burn, giving out heat and light, and forming what are called oxides of these substances.

The oxide of a metal is commonly called rust : as iron rust and tin rust ; but in chemistry these are called iron oxide or the oxide of iron, and tin oxide or the oxide of tin. When we say that iron rusts, we ought really to say that it oxidizes, which is the same as saying that it burns, for all burning is oxidation. When wood burns its carbon unites with the oxygen of the air, and forms CARBONIC ACID gas. If there were no oxygen in the air there could, of course, be no burning, and we should be deprived of all the comforts and conveniences which we get from fire.

We are accustomed to think that there must always be heat and light when anything burns ; but this is not necessary. There is no light and very little heat when burning takes place very slowly. Thus when iron rusts in the open air, the burning is so very slow that no light is seen and no heat is felt. If iron is burned quickly in a jar of oxygen, it burns as freely as wood, and gives out both light and heat. Not only iron, but all the other metals, with the exception of gold, silver, platinum, and a few other very rare metals, will burn or oxidize when heated in the air.

Oxygen was discovered by Joseph Priestly, an English philosopher and chemist, in 1774. Its present name was given to it by Lavoisier, a French chemist, in 1777.

The word oxygen means the acid-maker, it being made up of the Greek *oxus*, acid, and *gennein*, to make. Oxygen was given this name because it was once thought that all ACIDS were made by it.

OYSTER. It is not known when oysters were first eaten, but it is certain that they have been used as food by almost all peoples from the most ancient times. The Romans were great lovers of them, and they were the first to make oyster ponds in which they were bred and fattened for the table. It is said that the Emperor Vitellius could eat a thousand at a meal, but they must have been very much smaller than American oysters. One of the French kings made his cook a noble because he cooked oysters so well, and Napoleon is said to have always eaten oysters, when he could get them, on the eve of his great battles.

Oysters are found in almost all parts of the world, but they are not all alike, for there are said to be more than fifty kinds. Generally, those growing in cool climates have more flavor than those of hot countries. They grow commonly near shores, in water twelve to fifty feet deep, generally in quiet bays or in the mouths of rivers. They cannot live in fresh water, but sometimes they live a long time out of water. In some hot countries oysters fasten themselvesto trees growing in the water, and when the tide goes out they are left dry, but as they have water enough in their shells to last them until the next tide, they do not suffer from it.

The shell of the oyster grows in irregular layers, and the two sides are unequal. The lower side is

larger than the upper and bulges out more, and it is by this that it is fastened to rocks, limbs of trees, or other things at the bottom of the sea. The oyster is a very simple animal, but it breathes and eats like other animals. It has two pairs of gills, by which it separates from the water the small quantity of air which it needs; and, although it has no head, it has a mouth hidden under the folds of its mantle or skin, into which it sucks food from the water. Every oyster has a strong muscle fastened to the middle of each side of its shell, by means of which it is able to open and to close its shell. This muscle has to be cut through with a knife before an oyster can be opened.

Oysters lay great numbers of little yellow eggs, a single one sometimes laying many hundreds of thousands. The spawning season is in May, June, July, and August, during which months they are not so good to eat as at other times. It is a common saying that oysters are unwholesome in all the months which have not an R in their name. This notion is very old, being mentioned in a book called "Dyet's Dry Dinner," printed in 1599. The eggs of oysters are placed in the folds of the skin and are hatched there, and the little oysters do not leave the mother's shell until they are able to take care of themselves. They are so small that they are almost like dust, but when looked at through a microscope they are seen to have a perfect shell. During the spawning season the sea over an oyster bank is so filled with this living dust, or "spat," as the young oysters are called, that it is clouded. The spat float around until the current carries them against rocks or some other solid bodies, when they stick close to them and begin life like any other oyster. But only a small part of those that are hatched grow up, for millions of them are eaten by fishes, and unless they are born in still water great numbers are swept away by the currents. It takes an oyster about three years to grow up, and some do not reach their full growth before the fifth or sixth year.

Oysters sometimes grow so fast along the low coasts and river banks of the Southern States that they fill up the channels and change the course of the currents. If the branch of a tree be put into the water near one of these beds, it will soon be covered with young oysters, and in two or three years will be loaded down with large ones. Great numbers of small oysters, called seed oysters, were formerly brought every year from Chesapeake Bay and put into new beds in the flats around New York City and in Long Island Sound, and many are still thus brought; but most of the oyster beds are now supplied by the spat taken during spawning time and planted in new beds. There are miles of such beds in Long Island Sound, and they are growing larger every year.

The oyster is an acephalous MOLLUSK.

The word oyster is from the Latin *ostrea*, Greek *ostreon*, oyster.

OZONE. See OXYGEN.

P

PAINT. All paints are made up of two things, the substance that makes the color, usually called the pigment, and that with which the color is mixed. Pigments are mostly made from minerals, but some are got from vegetables and some from animals. Whites are usually LEAD carbonate, ZINC oxide, and CHALK; blacks are BONE-black, LAMP-BLACK, CORK-black, and BLACK LEAD; browns are umber (a brown earth found in the island of Cyprus); sienna earth (found near Siena, Italy; sometimes burned to make a deeper brown); bistre (made from the soot of several kinds of burnt wood); sepia (made from the CUTTLE-FISH), etc.; reds are red LEAD oxide, IRON oxides, ochres (earths colored with iron), vermilion (see MERCURY), carmine (see COCHINEAL), MADDER, etc.; yellows are ochres, LEAD chromate, etc.; blues are Prussian blue (see IRON), ultramarine (made from a blue stone called LAPIS LAZULI), smalt (made from the metal cobalt), INDIGO, verditer (see COPPER), etc.; and greens are verditer, verdigris, cobalt, etc., but greens are usually made by mixing various blues and yellows. Paints are mixed either with oil or water, and are therefore called oil paints and water-colors. Oil paints are usually mixed with LINSEED oil, but sometimes some kinds of nut oils are used. Linseed oil is boiled, before using, with some other things to make it dry quicker. Just before the paint is to be used, it is thinned with spirits of TURPENTINE. Artists' colors are ground in fine oil and put up in little metal tubes, which have a cover screwed tightly on the top. By taking off the lid a little of the paint can be squeezed out upon the painter's palette, and the rest kept safe from the air by screwing the cover on again.

Water-colors are mixed with water and a little glue or gum. Cakes of water-colors, usually sold in paint boxes, are made by pressing the colors, made into a thick paste with water and gum, in moulds and then drying them in heated air; but water-colors are now often put up in metal tubes, like oil-colors. Water-colors are largely used in miniature painting, map coloring, and small pictures. Kalsomine is a mixture of ground chalk with water and glue, colored with various things.

The word paint is from the Latin *pingere*, to paint.

PALMETTO, the common name of the palm trees which grow in the United States. There are four kinds, but the chief one is the cabbage palmetto, which grows in the south-eastern States from North Carolina to Florida. It is commonly four or five times as high as a man, but is sometimes higher, and more than a foot thick. The bud or cabbage is sometimes eaten, and palm wine has been made from its juice. Its leaves are used for thatching buildings, and for making hats, baskets, mats, etc. As the teredo or ship-worm will not eat its wood, palmetto timber is largely used in the South for wharves and other structures under water

The word palmetto is from the Spanish *palmito*, little palm, which is from the Latin *palma*, the palm of the hand, the leaves of the palm tree being thought to look like the palm of the hand.

PANTHER. Most writers think that the panther is only a kind of LEOPARD, but some say that the panther is larger, stronger, and darker-colored than the leopard. It is said also to be less common than the leopard, and to be found only in Africa, while the leopard is often found in Asia also. In South America the jaguar is sometimes called panther, and in North America the couguar, puma, or catamount, is frequently called by the same name, and sometimes also "painter," which is only a corrupt form of panther.

The panther is a very fierce and savage animal, and is much feared when wild, but it is said to be easily tamed, when taken young, and to then show much love for its master. A story is told of one that was given by the King of Ashantee to the English Governor of Cape Coast Castle on the west coast of Africa. He was a beautiful animal about two feet high, and of a dark yellow, spotted with black rosettes. He was so tame that he was allowed to roam all round the castle, and followed the governor everywhere like a dog. His favorite place was at the window of the sitting room which overlooked the whole town. He used to stand there on his hind legs, his fore paws resting on the ledge of the window with his face between them, and watch with great interest everything that passed below. The children used to stand there with him, and when he was in their way they would try to pull him down by the tail. When the governor went to England he carried his pet with him in a large cage. He arrived safely, but died in a few weeks from inflammation of the lungs.

The panther is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the cat family, to which belong also the LION, TIGER, LEOPARD, COUGUAR, LYNX, and common CAT.

The word panther is in Latin *panthera*, from Greek *panthēr*, a panther.

PAPAW, or PAWPAW, a small fruit-bearing tree or rather large plant which grows in the southern and southwestern United States. It is generally four or five times as high as a man and about six inches thick. Its wood is soft and worthless. Its fruit, which ripens in September, is a pod three or four inches long and about an inch thick, and looks somewhat like a banana, having a yellow skin when ripe. Its flesh is soft and sweeter than that of the banana, and has two rows of large flat seeds in it.

Another kind of papaw grows in South and Central America and the West Indies. Its fruit is about ten inches long and five broad, and has a thick ribbed orange-yellow rind. It is usually cooked with sugar and lemon juice, but is sometimes eaten raw. The leaves are used instead of soap for washing clothes. The juice of the ripe fruit is said to be good for freckles, and the sap of the tree will make tough meat tender.

The word papaw is from *pâpaya* a corrupt form of *ababai*, the name given it by the Caribs.

PAPER. Paper such as we use to write and to print on was not known to the ancients; but they had a kind of paper called papyrus, made from the inner bark of a rush which grew in Egypt. Papyrus was not made like our paper from a pulp. The inner bark of the plant was peeled off in thin narrow strips and laid side by side so that their edges would lap over each other. The sheets were then pressed, and the juice of the plant made the edges stick together. To make thick paper several layers were placed one above the other, some being put crosswise. The Chinese rice paper is not made from rice, as one would think from its name, but from the pith of a tree which grows in Asia. The pith is cut round and round into a thin slice, and then pressed out

flat. The Chinese were the first to find out how to make paper as we make it. The Arabs learned the art from them, and it then spread over Europe; but little paper was made in England before Queen Elizabeth's time. Before that, people wrote mostly on PARCHMENT or vellum.

Papyrus Plant.

Paper Materials. Paper is now made out of many different things, but chiefly from linen and cotton rags, old paper, straw, and several kinds of grasses and woods. Esparto grass, called by the Arabs alfa or halfa, brought from Algeria, Tunis, Tripoli, and Spain, is now much used in England. It makes the best paper, next to rags. In France straw is largely used. Wood paper is made in Europe chiefly of the wood of the silver fir, which is largely made into pulp in Norway and sent to other countries. Bank-note paper is made from the best linen rags; letter paper from linen and cotton rags; paper for printing books, from rags and from wood; paper for printing newspapers mostly from wood; and wrapping paper and other cheap kinds from straw. Paper is made from all these things in much the same way. The material is first made into a pulp or soft paste that looks like starch. Paper rags are usually very dirty, linen and cotton and plain and colored rags being mixed. They are first sorted, the linen rags being separated from the cotton, and the colored ones from the white ones. They are then chopped up in a machine called the rag-cutter, after which they pass through the duster, which blows out most of the dust from them. After being boiled in water with SODA and LIME, which takes out the color, grease, and dirt, they are put into the pulp machine. This machine is in three parts; the first washes the rags very clean, the second bleaches them white, and the third beats them into pulp.

Waste paper is sorted and dusted in the same way as rags. If the paper has been printed, the ink is taken out by boiling with soda; it is then bleached and made into pulp like rags, but it does not take so long to do it. Straw is first cut up into small pieces and boiled with soda to get out the resin or gum, and then made into pulp in the same way as rags and old paper. Rye straw is generally used in the eastern States and wheat straw in the western States. For making paper pulp from wood, poplar and basswood are mostly used, because they are very white and have but little resin in them. The wood is first cut up into small chips by machines which can make forty large cart loads of wood into chips in a day. The chips are boiled with soda, which takes out the resin, and afterward bleached

and made into pulp. When paper is made of two or three different things, the materials are mixed in the pulp. Wood and straw pulp have some cotton pulp put with them, and linen pulp is generally mixed with cotton. If the paper is to be colored, the coloring matter is put into the pulp. White clay is also added to it, which makes the paper heavier, smoother and thicker, but too much clay makes it weak and easy to break. A kind of glue called sizing is then put in, which hardens the surface of the paper. You could not write on paper made without sizing, because the ink would run just as it does on blotting paper, which has no sizing in it.

Paper Making. In the United States paper is now made entirely by machinery, but as the machines are hard to understand, I shall tell how it used to be made by hand. The pulp is mixed in a vat with water to make it thin enough to spread easily. The workman has what is called a mould, a frame covered with a network of very fine wires like gauze, woven crossways. Another kind of mould has the wires stretched across only one way, with a few cross wires to keep them in place. If you hold several sheets of writing paper up to the light, you will see that some look as if the paper were woven, like cloth, and in some there are many marks running up and down and only a few crosswise. These marks are made by the wires of the moulds. Paper made on the first kind of mould is called wove paper, and that made on the second, laid paper. You will also see other marks in the paper called water-marks. These ought to be called wire-marks, because they are made in the same way as the other marks, by wires placed in the moulds so as to make the figures or letters wanted in the paper. The reason why the water-marks and other wire marks show in the paper is that the paper is thinner in those parts. The water-marks sometimes give a name to the paper; thus foolscap paper was so called because the water-mark used to be a fool's cap and bells.

Besides the mould the workman has a thin frame called a deckle, which just fits on to the mould and is of the size of the sheet of paper to be made. The workman fits the deckle on to the mould, and holding the two in both hands dips them into the pulp, which covers the mould all over up to the deckle. He then shakes the whole gently so as to spread the pulp evenly over the wires, between which the water drains off. The deckle is next taken off and the mould passed along to another workman called the coucher, while the first workman fits the deckle to a second mould and dips up another sheet of pulp. The coucher spreads out a sheet of felt cloth, and by turning the mould over lays the sheet of pulp flat upon it. On top of the sheet of pulp he spreads a second sheet of felt, than another sheet of pulp, and so on until he has piled up a hundred and thirty sheets, each between two sheets of felt. The whole pile is then put into a press and pressed until nearly all the water is out. The felts are next taken off and the sheets are pressed in a pile by themselves, and afterward separated and pressed a third time, when they are hung up on lines in rooms to dry. After drying for one day and night, they are sized, if the sizing was not put into the pulp, by being dipped into very thin glue water mixed with a little alum. The sheets are then pressed again, and again dried for several days, when they are finished by pressing them between glazed pasteboard and hot metal plates, or passing them through hot polished metal rollers.

The mode of making paper by machinery is the same in principle. The pulp is taken up from the vat on a wire gauze mould, which, instead of being only the size of a sheet, as in the hand mould, is end-

less and turns round two rollers just like the leather belt of a steam-engine. It has raised sides, called the deckles, which prevent the pulp from running off. The mould has a shaking motion like that which the hand-workman gives to his mould, which lays the pulp evenly. The sheet of pulp is then carried on to a belt of felt which passes it through rollers to press out the water, and over several other hollow rollers filled with hot steam, which dry it. Other rollers press out most of the wire marks and the marks made by the felt, and polished iron rollers give it a smooth and glossy surface. The paper, which comes from the machine in one long sheet like wall paper, now passes to another machine which cuts it into sheets. It is then folded and put up into quires for sale. It takes about three weeks to finish fine paper by hand; but the same work is now done by machinery in a day, and paper made on the best machines is as good as that made by hand.

Uses of Paper. Paper pulp is also made into many other things, such as pasteboard for book-binding and for boxes, PAPIER-MACHÉ, boards to cover the sides and roofs of houses, ropes and twine, collars and cuffs, racing-boats, water-buckets, tubs, water pipes, car-wheels, and furniture. The Chinese and Japanese are very skilful paper-makers, and make clothing, hats, shoes, pocket handkerchiefs, and umbrellas out of it.

Though linen, cotton, and hemp rags make the best paper, a great many other things have been tried by paper-makers. In the British Museum is a curious book on paper-making, made in 1775, by a German named Jacob Christian Schaffer, the sixty leaves of which are made of sixty different kinds of paper. Among them is paper made from the bark of the willow, beech, mulberry, linden, and hawthorn, the tendrils of the grape vine, the stalks of the nettle, the down from the flowers of the black poplar, many kinds of leaves, and straw, reeds, moss, lichens, wood-shavings, sawdust, fir cones, and potatoes. Patents have been taken out both in Europe and the United States for making paper from a great number of things, but few of the things have proved to be good for much.

Pasteboard is so called because it was once made by pasting sheets of paper together until it was thick enough, and then pressing it smooth; but it is now made from pulp, just as paper is, only the pulp is much thicker. The pulp of yellow and brown pasteboard is made from straw, pieces of old rope, JUTE, and other coarse things.

The word paper is from the Latin *papyrus*, Greek *papuros*, the paper plant of Egypt.

PAPER BAGS and **BOXES.** See ENVELOPES.

PAPER-HANGINGS, or **WALL-PAPERS.** The PAPER for paper-hangings was once made by hand in square pieces and then pasted together to make rolls twelve yards long; but it is now made like other paper, in long rolls on machines, and afterward cut up into the lengths wanted. Much more clay is put into the pulp than into that of other paper. In former times paper-hangings were printed with blocks or STENCIL plates, but most of them are now printed on machines, just as CALICOES are printed. Satin paper, which has a shiny surface like satin, is made by coating the paper with powdered French chalk and then rubbing it with a brush until it is smooth. The printing is generally done after the satin face is put on. The fuzzy paper that feels like velvet is called flock paper. It is made by coating the paper with varnish and then sprinkling it with the flock, which is made from the shearings of woollen cloths from cloth mills, ground up and sifted until it is very fine. In gilded papers the pattern is first printed with varnish, and the gold

leaf is then laid on; the part which covers the pattern sticks fast, and the rest is brushed off. Some of the finest papers are painted by hand.

PAPIER-MACHÉ. The cheaper kind of papier-maché is made of coarse PAPER pulp pressed into moulds; the better kind, of sheets of paper glued or pasted together and pressed into moulds and then dried. When damp, sheets of paper thus pasted together can be moulded and pressed into any shape, and when dry they become so hard that they can be planed and filed. The surface is smoothed with PUMICE-stone and then several coats of varnish are put on, each one being dried. When a fine surface is made it is ornamented with gilding and painting, and frequently with flowers and other figures cut in MOTHER-OF-PEARL, silver, and other things. A great many articles are made of papier-maché, such as trays, boxes, album and portfolio covers, screens, tables, chairs, and other furniture, and also jet buttons and ornaments, but they are now mostly out of fashion.

A kind of papier-maché called *carton pierre* (French, stone paper) is made of paper pulp, whiting, and glue. It is used instead of plaster of Paris (see GYPSUM) for making ornaments and cornices for rooms. Such ornaments are stronger and lighter than those made of plaster, and can be easily screwed on to walls and ceilings. Papier-maché is also much used for making casts of type for stereotyping (see PRINTING).

Papier-maché is French for mashed paper, from *papier*, paper, and *macher*, to chew.

PARCHMENT, the skin of an animal, made fit to write on. Parchment is usually made of sheepskin. After the wool has been scraped off the skin is steeped in lime water, which takes out the grease. It is then stretched on a frame called a "herse," and scraped with a knife shaped like a half moon, which takes off the remains of flesh, dirt, etc. After this it is sprinkled with powdered chalk or quick-lime and ground down with PUMICE-stone. Parchment used for covering DRUMS is made from the skins of asses, calves, or wolves, those of wolves being the best.

Vellum is a fine kind of parchment made from the skins of calves, goats, or dead-born lambs. Parchment and vellum are much more lasting than paper, and are largely used for deeds and other important law papers, which have to be kept a long time.

The word parchment is from the Latin *Pergamena charta*, paper of Pergamus, a city in Asia Minor, where parchment is said to have been first made.

PARROT. There are about three hundred kinds of parrots, most of which live in very hot countries. They are found nearly all over the world excepting in Europe. Most of them have beautiful feathers, generally green, but sometimes blue, gray, red, or yellow. Their voices are harsh and disagreeable, and the woods where they live are kept lively with their loud cries. They are brighter than birds usually are, and may be taught to imitate all kinds of sounds and even to talk. Parrots use their hooked bills as well as their claws in climbing trees, and use their feet like hands to carry their food to their mouth. They live chiefly on fruits and seeds. The paroquet, macaw, and cockatoo are kinds of parrots. There are many parrots in Central and South America, but the only kind in the United States is the Carolina parrot, a bluish-green bird, with a white bill. It is found mostly in the southern and southwestern States, but has been seen as far north as Michigan.

The parrots usually kept as pets are the green South American parrot, and the gray parrot with scarlet tail, from West Africa. The gray parrot is noted for its tameness,

mischievousness, and power of imitating sounds. It can be taught to sing songs and to speak long sentences. Parrots will live seventy-five years, and some have reached nearly a hundred years.

Many wonderful stories are told about parrots. It is said that in the sixteenth century a cardinal paid a large sum for a parrot because it could say the Apostles' Creed; and another parrot is said to have taken the place of the chaplain on a ship and to have gone through with the prayers and the litany to the sailors. Goldsmith tells a story of a parrot belonging to King Henry VIII., which, being kept in a room on the bank of the River Thames, had learned to repeat many things which it heard the boatmen say. One day it fell into the river, and began to call out in a loud voice: "A boat! a boat! twenty pounds to save me!" A waterman, thinking someone was drowning, jumped into the water and swam to where he heard the sound, and was surprised to find it was only a bird. Finding that it was the king's parrot, he carried it to the palace and claimed the reward, which the king paid.

Another parrot would always laugh when told to do so, and then say, when it had done, "Oh, the great fool who made me laugh!" A man who kept glassware for sale had a parrot which always cried out, when its master broke anything: "Awkward brute, he never does anything else!" A gray parrot belonging to an English gentleman would ask for everything it wanted and give orders; and would sing several songs and whistle some airs well, always beating time with its foot. When it sang or whistled a wrong note, it would stop and go all over it again, and it never made the same mistake twice.

The parrot belongs to the order *scansores*, or climbing BIRDS.

The word parrot is from the French *perroquet*, which is from *Pierrot*, a short form of *Pierre*, Peter.

PARSLEY, a common garden plant, whose leaves are much used for seasoning soups and for dressing dishes. It was first brought from the south of Europe, but now grows well almost anywhere in the United States. Its leaves contain a fragrant oil the smell of which will hide other odors; and for this reason they are often chewed after eating onions.

Parsley, which grows wild around the Mediterranean, was not cultivated by the Romans. Charlemagne ordered it to be cultivated in his gardens, and it gradually came into common use, but it was not grown in England until 1548.

The word parsley is from the old English *perseley*, French *persil*, which is from the Latin *petroselinum*, rock-parsley, from the Greek *petros*, rock, and *selinon*, parsley.

PARSNIP, a common plant, cultivated for the sake of its root, which is used for food both for men and cattle. It grows wild in southern Europe and in parts of Asia, but not in the United States. The flesh of cattle fed on parsnips is excellent, and the butter of cows fed on them is better than that made by other kinds of winter feeding. In Ireland a fermented (see BEER) liquor, and in other countries a kind of marmalade and a wine are made from them.

The word parsnip is changed from pastnip, which is from the Latin *pastinaca*, a parsnip. It is sometimes spelled parsnep.

PARTRIDGE, the common name of a family of birds which includes also the quail. It is found almost all over the world, but there are no true partridges in the United States. The bird called partridge in New England is the ruffed GROUSE, and the one called partridge in the South is the QUAIL. The true partridge, of which there are several kinds, is found in southern Europe and in parts of Asia and Africa. Its flesh

is much liked, and the bird is the delight of the sportsman.

The word partridge is in French *perdrix*, which is from the Latin *perdix*, a partridge.

PASTE. Common paste used by bill-stickers, paper-hangers, bookbinders, and others, is made by mixing about half a pound of wheat flour with a quart of cold water. A little powdered alum is then put in or, if it is to be used by bookbinders, a little powdered resin, which adds to its stickiness. The mixture is then boiled, care being taken to stir it to keep it from burning, until it is of the right thickness. This is the kind of paste used by passe-partout makers to stick paper to glass.

Polishing Pastes are mixtures of rotten-stone, emery, lard, soft soap, olive-oil, etc., used for polishing iron, brass, pewter, and other metals.

Glass Paste is a fine kind of glass of different colors, used for making false precious stones. The glass most used is called strass, German *stras*, named after the man who first found out how to make it. This can be colored with oxides of metals (see OXYGEN) so perfectly that the false stones can scarcely be told from the real ones.

The word paste is from old French *paste*, Italian and Spanish *pasta*, Greek *paste*, barley porridge.

PAVEMENT, a hard covering for streets, walks, and floors. In streets where there is much travel great care must be taken to have a good pavement; and many different kinds of materials have been used for this purpose in many different ways. In some places bricks are used, in others iron and wood blocks, in others stones in different shapes, and in others various things mixed with ASPHALTUM or with CEMENT. Bricks are too soft for streets where heavy wagons pass, and soon wear out; iron blocks are too hard, soon become slippery, and make much noise; wooden blocks are easy to ride over, and almost noiseless, but are apt to became slippery and to decay soon; and many kinds of stone pavements either become slippery or wear into ruts. In this country cobble-stones, or round stones found among the gravel of sea beaches and river sands, have been much used. They make a good foothold for horses, but are apt to get out of place, and streets laid with them often need mending. The best and most lasting pavements in the streets of cities in the United States have been those made of stone blocks set close together. Several sizes of stones have been tried. The Russ pavement, once much used in New York, was made of blocks of granite nearly square, but it wore smooth and became slippery. The Belgian pavement, made of smaller blocks, is better, and is much used in many cities; but the best is that called the Guidet pavement, made of narrow blocks set on edge. This is the pavement now laid in Broadway, New York.

Pavements made of a mixture of asphaltum, gravel, and broken rock have been tried in many cities in the United States, but have usually failed in streets where there is much travel. But such pavements have been more successful in France, and it is thought that good and lasting roads will soon be made in this way. They are very easy to ride over, and are not so noisy as stone. A kind of asphalt called grahamite, much used in this country for road-making, is brought from West Virginia. Sidewalks are mostly paved with flagstones, a kind of sandstone which splits easily; but some cities are largely paved with brick, and sometimes very large and costly slabs of granite are used. Many walks, especially in and around parks, are now made of gravel, broken stones, and sand, mixed with cement or asphaltum. Pavements of houses, courtyards, etc., are sometimes made of marble slabs, MOSAICS, or TILES.

The word pavement is from the

Latin *pavimentum*, pavement, from *pavire*, to beat or ram down.

PEA, the common name of the FRUIT of the pea vine, much cultivated for food. The pea vine is supposed to have been first brought from western Asia. Peas have been found in tombs at ancient Thebes. The plant was known to the Greeks and Romans, but was not cultivated in England until the time of Henry VIII. (1506–47). It was brought to this country by the early settlers. There are about fifty kinds of peas, which differ only slightly from each other: some are smooth and some are wrinkled; some are green when ripe and some are yellow or yellowish white; some are early and some are late; and some are sweeter than others. Garden peas are usually eaten before they are ripe, but field peas are allowed to ripen. When dry the vines are gathered and the peas threshed out; the vines are fed to sheep and cattle, and the peas themselves to sheep and swine. Dry peas have the outer shell rubbed off by a machine, and the inner part then splits into two, and makes split peas, so much used for making soups. In some countries peas are ground into meal and made into cakes. As an article of food peas are very valuable, as they are more than half made up of STARCH and caseine (see FOOD).

What is called the cow pea in the South is more like a bean than a pea in its looks. It is highly esteemed as a food for cattle. The sweet pea, much cultivated in gardens for its pretty flowers, which are white, pink, scarlet, purple, blue, etc., was first brought from Sicily.

The word pea is from the Anglo-Saxon *pisa*, Latin *pisum*, Greek *pison*, pea.

PEACH, the FRUIT of a tree of the same kind with the almond, apricot, plum, and cherry. Its native country is probably China, where it is called *tao*, and it is mentioned in books at least two thousand years before Christ. The peach differs from the nectarine only in having a rough instead of a smooth skin; that is, the nectarine is simply a smooth-skinned peach. There are freestones and clingstones among nectarines, as well as among peaches. The peach tree is of medium size, being seldom more than three or four times as high as a man. It is largely cultivated in Delaware, Maryland, Virginia, and New Jersey, and immense quantities of peaches are sent in baskets and crates from those States to the northern markets. There are also large peach orchards in Michigan and Illinois, which supply many of the western cities, and very fine peaches are raised in the southern States and in California. About a basket of fruit is usually got from each tree. The peaches are picked when still hard, for if allowed to ripen on the tree they would be too soft when they reach market. Great quantities are preserved by canning and drying. The cans are of tin, and are made very cheaply by machinery. The peaches, peeled and cut into halves, are put into them through a round hole in the top, and syrup is then poured in until the spaces between are filled. The cover, which has a small hole pricked in it, is then soldered on by melting SOLDER with a hot iron. The heat of the iron swells the air in the top and drives it out of the little hole, which is then closed with some solder. The cans are next lowered into a vat of water, and heated boiling hot. If air-bubbles escape from a can it is taken out; those from which no air is seen to rise are left in until heated through, when they are removed, allowed to cool, and packed in boxes for sale. Tomatoes and other fruits are canned in the same way.

Dried peaches are made by slicing them and drying them in the sun, in ovens, or in rooms heated by stoves. Those dried in the sun are much darker colored than the others, and are not so good. Peach brandy is

made by pressing out the juice of the fruit, letting it ferment and then distilling (see ALCOHOL). Fresh peach leaves have the taste and smell of bitter almonds. Peach water, much used for flavoring in cookery, is made by bruising them, mixing the pulp with water, and distilling it.

The word peach is in French *pêche*, Italian *persica*, from the Latin *malum Persicum*, Persian apple; the fruit having been first brought to Europe from Persia about the time of Christ.

PEACOCK. This splendid bird has been known since the most ancient times. It was one of the precious things brought from Asia by King Solomon's ships, and it was probably carried into Europe by Alexander the Great on his return from India. When first seen in Athens it is said to have brought together great crowds of people, who came in from the country to see it; but in time it became plentiful both in Greece and Italy, and then spread all over Europe.

The peacock is one of the most beautiful of birds, but the peahen, as the female is called, is not at all handsome, being of a brownish color, somewhat like the hen turkey. The peacock is elegant in form and graceful in movement; its head has a splendid crest of feathers; its feathers are generally bluish green with bronze shadings, and its tail, which is very large, is emerald green, purple, and gold studded with richly shaded eyes. In the spring the peacock struts, spreads its tail, and takes great delight in showing its splendors. But at the end of summer it loses its fine plumage, which does not come out again till spring. Sometimes white peacocks, or white mixed with other colors, are seen, but they are not common. The cry of the peacock is very harsh and loud.

Wild peacocks are still plentiful in the forests of India. When hunted they often get away by running, for they are fleet of foot, but they cannot fly very well. They roost on the limbs of the highest trees, but make their nests on the ground. Tame peacocks also love to get up as high as they can, and they take pleasure in flying to the tops of the loftiest buildings. They sometimes do much mischief to roofs by tearing up tiles and shingles.

The feathers of the peacock are much used for trimming clothes and fans; and for ornamental brushes. Its flesh was much eaten in ancient times. The Romans thought it a great delicacy, and the emperors used to have dishes served at their feasts made entirely of the brains and tongues of peacocks; but peacocks are not much eaten now, as their flesh is not so good as that of the turkey and other fowls.

The peacock belongs to the order *rasores*, or scratching BIRDS, and to the pheasant family.

The word peacock is made up of pea, Anglo-Saxon *pâwa*, Latin *pavo*, peafowl, and cock, Anglo-Saxon *coc*, the male of any fowl.

PEANUT, the fruit of a leguminous PLANT common in warm countries. It probably grew first in Brazil, whence it is supposed to have been carried early by the Portuguese slave ships to Africa and the islands south of Asia. It is sometimes called also ground pea and ground or earth nut, and in the southern States gouber or goubers nut. Still another name for it is pindal or pindar, and in western Africa it is called mandubi. The plant is a trailing vine, with small yellow flowers. After the flowers fall the flower stem grows longer, bends downward, and the pod on the end forces itself into the ground, where it ripens.

Peanuts are raised in immense quantities on the west coast of Africa, in South America, and in the southern United States. The vines are dug up with pronged hoes or forks, dried for a few days, and then stacked for about two weeks to

cure. The pods are picked by hand from the vines, cleaned in a fanning mill, and sometimes bleached with sulphur, and then packed in bags for market. Peanuts are sometimes eaten raw, but usually roasted or baked. In Africa and South America they form one of the chief articles of food. Large quantities of them are made into an oil much like olive oil, and which is used in the same way. It is also largely used in the manufacture of soap. A bushel of peanuts, when pressed cold, will make a gallon of oil; if heat is used, more oil is made, but it is not so good. In Spain peanuts are ground and mixed with chocolate. Peanut vines make good food for cattle.

The peanut probably gets its name from the shape of its pods, which are like those of the pea.

PEAR, the FRUIT of a tree of the same family with the apple. The pear is one of the best and most valuable fruits of mild climates. The tree grows wild in Europe and in the mild parts of Asia, but there were no pear trees in America until they were brought here by the early settlers. The wild pear is either a shrub or a very small tree, with thorns, and bearing small puckery fruit; but the cultivated tree is often larger than the apple tree, with a trunk sometimes nearly a yard in thickness.

There are many kinds of pears, more than 1000 of which grow in the United States, but only a few kinds are raised for market. Among the most popular kinds cultivated here are the Bartlett, which is early, and the Seckel (wrongly called Sickle by many), which ripens in the autumn. The Bartlett was first raised in England about one hundred years ago by a man named Williams, and it is known there by his name; but it was first made known here by a Mr. Bartlett, of Boston, and has always been called after him. The Seckel is an American pear, supposed to have first grown from the seed. Besides these there are several kinds called winter pears, which are picked when frosty weather begins, and ripened indoors. Pears are preserved by canning like PEACHES, or dried. An agreeable drink called perry is made from them in the same way that cider is made from apples. The wood of the pear tree is hard and close-grained, and is used by turners, and by engravers for coarse work. It is also sometimes dyed black and used by cabinet makers for ebony.

The word pear is in Anglo-Saxon *peru*, French *poire*, from the Latin *pirum*, pear.

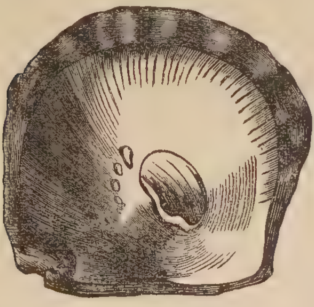
PEARL, a substance found within the shell of the pearl oyster and used as a jewel. The ancients believed that pearls are formed by drops of dew that fall into the shells of the oysters while open at night. If the dew was pure the pearls would be beautiful and clear; if impure, they would be dull and muddy. They thought, too, that the pearl remained soft and tender while in the sea, but hardened on being taken from it. It is not now known exactly how pearls are made, but they are supposed to be a product of disease: that a grain of sand or some other substance gets into the mantle (see MOLLUSK) of the oyster which, being unable to remove it, covers it with mother-of pearl, the same substance as that of which the pearl is made, and thus forms a round pearl.

Pearl oysters grow in beds the same as the common oyster, but they are not much like it in looks. There are two principal kinds, one, called the true pearl oyster, which produces the finest pearls, being not much larger than the palm of a man's hand. The shells are too thin to be worth much for mother-of-pearl, and are thrown away after the pearls have been taken out. The other, shown in the picture, is larger and thicker, and, while producing good pearls, is also valuable for the

shell, called in commerce "silver-lipped" pearl shell, which is worth from $400 to $700 a ton. The two shells of one of this kind will often measure, when opened out, a yard

Pearl Oyster Shell, Outside.

across. Both kinds of oysters are found off the coast of Ceylon and in the Persian Gulf, in the Sulu Sea, and off the north and west coasts of Australia. The pearl oysters of the Bay of Panama and the Gulf of California have smaller and thinner shells than the "silver-lipped" and are called "Panama" or "bullock-shell." Those in the Caribbean sea and other parts of the West Indies,



Pearl Oyster Shell, Inside.

and the northern coast of South America, are still different, being known in trade as "blue-edged" or "black-lipped" pearl shell. Of these are made the smoke-colored pearl buttons.

The oldest and most famous pearl fisheries in the world are those of the Persian Gulf and of Ceylon. The former are worked by Arabs, and most of the pearls got are sold in the East. The Ceylon fisheries are owned by the government, which takes for its share three-fourths of oysters caught. About 250 boats and 10,000 men are engaged in the fishery, which begins in March and lasts six weeks. The boats are all numbered and are divided into fleets of about fifty each, which take turns in going out. Each boat has its rowers and ten divers, each pair of whom has a diving-stone weighing 40 pounds, which is fastened to the boat by a long rope. The boats are on the oyster bank by sunrise and on the firing of a gun work begins. The divers work in pairs, one tending the rope while the other dives. The diver puts his foot in a loop in the rope near the stone and is thus carried quickly to the bottom, where he generally stays fifty to eighty seconds, though some are able to remain under water two minutes or even longer. He wears around his neck a band to support a basket, into which he puts the oysters he gathers on the bottom. Into the band are usually stuck one or two spikes of iron-wood, about a foot long and sharpened at each end. If a shark comes near, the diver tries to put one of these into his mouth, so that when closing his jaws he fastens them together and is thus rendered unable to bite. When the diver gets tired the rope-tender exchanges places with him. Each pair of divers keeps their catch separate in nets or baskets. At noon another gun is fired and all the boats go in shore. The oysters are carried to the government sheds, where they are divided into four heaps, one of which the divers remove as their share. The others are then assorted into piles of a thousand each and sold by public auction.

The oysters are left in the hot sun to rot and dry, when the shells are

opened and washed in sea-water and the pearls taken out. About two pearls are found in every hundred oysters; and if a thousand oysters produce pearls worth $100 the catch is considered a good one. The pearls are separated into classes, according to size, by passing them through ten or twelve brass colanders called baskets, of the shape and size of large saucers, the first one of which has 20 holes in it, the next 30 and so on, and the last 1000. They are next examined for shape and color, and then priced according to their value. The number of pearls found valuable for jewelry is very small, as a really fine pearl is as scarce as a fine diamond. The usual sizes are from one and a half to three times the size of a pea. Most of them, however, are small, called "seed-pearls," and many are imperfect. These are ground to powder and sold for medicine in the East, where pearl powder is thought to be good for strengthening weak eyes, and for nervous and other diseases. Rich East Indians and Persians use it, too, instead of lime to mix with the betel nut which they chew.

Different places produce pearls of different colors; rosy pearls are found in the waters of Japan and the Celebes; greenish ones in the Marienne Archipelago; bronze ones in the Gambier Islands; black ones in the Gulf of Mexico and the Gulf of California; and pure white orient pearls in the Gulf of Persia and off Ceylon. Two ruby red pearls are said to have been found in Ceylon a long time ago, but no more have been obtained. Pink pearls of great beauty are got from conch shells in the West Indies and Panama, but they are not true pearls and lose their color in time, which real pearls never do. Pearls are found in the United States in the common clam and in the fresh water mussel and other fresh water shells. Some of them are very fine, some being delicately tinted with pink, brown, purple, etc. In 1857 a beautiful white lustrous pearl, weighing 93 grains, was found in a brook near Paterson, N. J., and sold to the Empress Eugénie for $2500; it is now worth $10,000.

Pearls have been prized in all ages. Cleopatra, who had many fine ones, is said to have dissolved a very large pearl in vinegar while at table one day and drunk it; but the story cannot be true, for it would take a very long time to dissolve a pearl in vinegar, and if she had used acid strong enough for the purpose she could not have drunk it with safety. Another pearl of hers is said to have been so large that it was cut in two and made into ear-rings for the statue of the Capitoline Venus in Rome. In the last days of the Roman Empire pearls were so common among the wealthy classes that they used to ornament their sandals with them. The Shah of Persia is said now to own the finest pearls known, but probably the most beautiful one is in the Zosima Museum, Moscow. It is perfectly round, is about as large as a common marble, and is so pure as to be almost transparent.

Artificial Pearls, or false pearls, are made of hollow glass beads, covered on the inside with what is called essence of pearl. This is made from the scales of dace, roach, and some other small fishes, which when soaked in water give off a kind of pearly film. The pearl essence is mixed with a little isinglass and blown while hot into each bead by means of a little glass tube. When dry the beads are filled with white wax, which gives them weight and makes them less easy to break. These pearls are made so perfectly in Paris that they can scarcely be told from real pearls. Roman pearls are colored with the scales of a small fish like the smelt, found only in the Tiber. They are used mostly for beads.

The Chinese are said to force oysters to make pearls by putting small

beads made out of mother-of-pearl into the shells of live oysters and then putting the oysters back again into the sea, where they soon cover the beads and make them into large pearls. They also put in little metal images of their gods, and they are thus changed into beautiful pearl ones.

The word pearl is in Old English *perle*, Middle Latin *perula* or *perla*, a little pear, from *pirum*, a pear.

PEAT, a vegetable substance made up of partly decayed roots, stems, and leaves of plants. When dried it is often used for fuel in countries where wood and coal are scarce and dear. Peat is found mostly in cold countries, as vegetation in very hot countries rots too quickly to form it. Some peat is red or black, but the best is dark brown or snuff-color, and is quite thick and heavy. It is dug out of bogs or swamps, and has to be dried before it is fit for fuel. When very soft it is sometimes worked into a paste and moulded into cakes or blocks. Machines have been made to grind peat to a pulp and then to press part of the water out by passing it between iron rollers. The paste is then moulded into bricks and dried, either in the sun, or by furnaces. This makes good fuel, but it is not so cheap as COAL. See ROCKS.

Peat is made into charcoal, which is better than wood charcoal for smelting iron. It yields also a good gas, which burns almost as well as coal gas, and several other useful things, such as acids, oil, naphtha, and tar. It is also an excellent preservative, meat, fish, vegetables, and fruits being kept fresh in it for weeks.

The word peat is from the Old English *beat* or *beating*, turf for fuel.

PECAN, a nut, the fruit of a kind of hickory tree that grows wild in the southwestern United States, from Illinois southward. The tree, which is 60 to 70 feet high, though sometimes higher, has a coarse-grained wood, good for little else but fuel. The nut, which is shaped like an olive, is an inch to an inch and a half long, and has a smooth thin shell and a sweet oily meat. It is very good to eat and it yields, when pressed, much oil.

The word pecan, formerly written also paccan, is from the French *pacane*, Spanish *pacana*, which is probably of Indian origin.

PECCARY, a mammal of the hog family, found only in America. It looks like the common hog, but is smaller, and the head is larger in proportion to the body and more pointed, while the legs are thin and slender. The collared peccary, called also the Texan and the Mexican hog, is found from Arkansas and Texas through Mexico and most of South America. Peccaries live in woods and swampy grounds, going generally in parties of eight or ten. Their food is nuts, grain, fruit, seeds, roots, and whatever living thing they can catch. They sometimes break into fields and do great damage. When attacked they are bold and vicious, and often kill dogs and sometimes wound huntsmen with their sharp teeth. Their flesh is white and tender.

The word peccary is from *paquiras*, the South American name.

PELICAN, a large web-footed water-bird, remarkable for its long and broad bill with a pouch or bag under it. Pelicans live along the shores of seas, lakes, and rivers, and feed entirely on fish. They are strong flyers, and hover over the water in flocks, swooping down on their prey whenever they see a fish, and storing it in their pouch until it is full, when they go to some lonely place to eat it. They are very greedy, and it is said that one of them will eat in a day food enough for six men. Some kinds of pelicans live in Africa, some in Asia, and some in eastern Europe. There are two kinds in the United States—the white pelican, found in winter along

the coast of the Gulf of Mexico, which in summer goes up the rivers to the Rocky Mountains, and the brown pelican, which lives all the year round on the southern coast. The flesh of the pelican is eaten by negroes and Indians, but it has a strong, fishy taste, and is very tough. The pelican is the emblem of the State of Louisiana, and is represented on the State seal as sitting on its nest feeding its young.

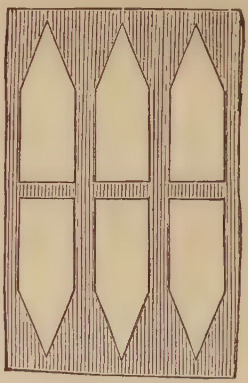
In old times it was thought that the pelican feeds its young, when food is scarce, with blood drawn from its own breast, and pictures are sometimes seen in which it is shown doing this. This silly story rose from the fact that this bird feeds its young by pressing the red point of its bill against its breast, which brings up the fish from its pouch. The male does the same thing to feed the female when sitting.

The pelican belongs to the order *natatores*, or swimming BIRDS.

The word pelican is from the Low Latin *pelecanus*, pelican.

PEN. In ancient times pens were made out of reeds, but after paper came into use they were made from quills, mostly those of the goose, but sometimes of the swan, crow, turkey, and ostrich. Quills for pens are plucked from the wings of live geese, each wing furnishing about five good quills. They are at first tough and soft, and covered with a kind of skin, so that they cannot be slit evenly; but after heating in hot sand, which dries up the oil in them, the skin cracks and peels off. This, which is called "dutching," because it is supposed to have been first done in Holland, gives them the color of thin horn. They are then dipped into boiling alum water or weak nitric acid. The quills, thus prepared, are tied up into bundles for sale. When made into pens, they are cut by hand by the pen-cutter's knife. Quill pens are now out of fashion, but are still used by many people, because they write smoother than steel pens.

Steel Pens are made from sheets of fine STEEL rolled to the right thickness, and cut into slips wide enough to cut out two rows of pens placed end to end, as shown in the first



Steel with Blanks cut out.

picture. The flat pieces thus cut out are called blanks. The blank for a common pen is shown in the second picture, and for a barrel or round pen in the third picture. The next operation is to cut the two side slits, which make the pen more limber. These are cut by punches, worked by hand. Then the long hole between these slits, made to hold the ink, is punched in the same way. The blanks are next softened by heating, when the maker's name and the number or letter of the pen is stamped on the back, and they are then rounded by being stamped between two DIES, one of which fits into the other. Barrel pens are first stamped in the same kind of a die, and then in another in which both the upper and the lower sides are hollowed out. The blanks, which have now the form of pens, are then hardened by heating them red-hot and cooling

Blank for Common Pen.

them suddenly in oil. They are next whirled round very fast in a barrel with sand and emery, which cleans and brightens them. The nibs or points are then ground on an emery wheel, after which the slit is cut. This is the most important part of the work, and is done by two sharp punches, one fixed below and one above, the edges of which come together like scissors. The pens are now heated in a metal barrel, which turns round over a charcoal fire, until they are of the right color. After cooling they are glazed with a kind of varnish, and when dry are put into boxes.

Blank for Barrel Pen.

Gold Pens are made in nearly the same way as steel pens; but the nibs are made hard by soldering on to them little pieces of iridium, one of the hardest of the metals. The points are then ground down on an emery wheel, and the pens are finished by cleaning them in weak nitric acid and by polishing them on a wheel.

The word pen is from the Latin *penna*, a feather or quill.

PENCIL. There are four kinds of pencils: those made of hair, of black lead, of chalk, and of slate. Hair pencils, which are used for drawing and painting in oil or water colors, are told about in the article BRUSH.

Lead Pencils are made from graphite or BLACK-LEAD. Before this mineral was found out pencils were made of common lead, which will make a light mark on paper. When graphite, which has no lead in it, was first used, the mark made by it was so much blacker than that of common lead, that it was called black-lead, and the pencils made from it black-lead pencils, to distinguish them from common lead pencils.

In making leads for pencils in former times the graphite was ground and made into a paste with water, and then pressed into blocks, which were afterward sawn up into square sticks. Each lead was set into a groove cut in the side of a square wooden stick, another piece of wood was glued on top of it, and when dry the pencil was turned round in a lathe. This is the mode of making pencils described in almost all other cyclopædias, but most of the lead pencils now in use are made in a different way.

The best lead pencils are now made in the United States, the purest black-lead being found here. The black-lead, which is brought from the mine in lumps, is crushed fine under water, on the top of which it floats off. It is then floated through several tanks or tubs, each of which is lower than the one before it. The coarsest grains settle to the bottom of the first tub, the next coarsest to the bottom of the next, and so on until the finest grains are all in the last tub. For very fine pencils only the settlings of the last tub are used, but for common ones the settlings of the two tubs before the last will do. The graphite is next mixed with a kind of pipe-CLAY brought from Germany, enough water being put in to make it about as thick as cream, and this is ground together until it is perfectly mixed. The clay makes the difference between soft and hard pencils. In hard pencils the lead is made of half clay and half graphite, but in medium ones there are about seven parts of clay to ten parts of graphite.

After grinding, the mixture is put into CANVAS bags and pressed until the water runs out and leaves it a thick dough. This is put into a small iron cylinder or barrel, which has a tight-fitting piston or plunger working up and down in it. In the bottom of the barrel is a small hole

of the size and shape of the lead wanted, and through this the lead is slowly forced, coming out in a long piece which coils up like a coil of wire on a board beneath. This is cut up into pieces, which are straightened and hardened by baking, when they are ready to be put into the wood cases.

The cases are made of a soft, close-grained CEDAR which grows along the coast of Florida. This is the best wood in the world for this use, and much is sent to Europe to be made there into pencils. It is sawed up at saw-mills in Florida into little thin boards of the length and half the thickness of a pencil, each piece being wide enough for making six pencils. Each one of these is run through a machine which smooths one side of it and cuts six grooves or places for the leads at the same time.

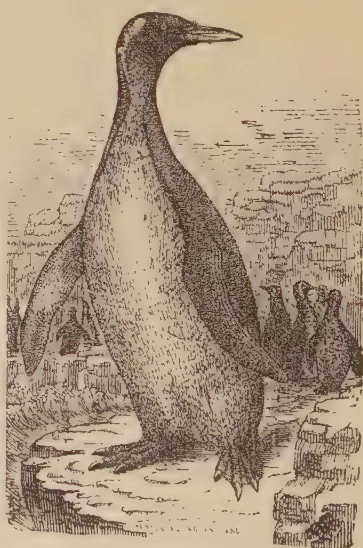
The putting in of the leads is done by girls. One girl takes up one of the little boards, lays leads in the six grooves, and passes it to a second one, who puts over it another board, which has been smeared with hot glue by a third girl. The boards are then screwed up tight in an iron frame and left to dry. When dry the ends are ground smooth on a wheel covered with SAND-PAPER, and the boards are then put one by one into a machine which cuts away all the waste wood and shapes the six pencils on one side. The boards then go through another like machine which shapes them on the other side, and they fall into a basket—six pencils all ready for varnishing and stamping. Some pencils are made round and some six-sided. Colored pencils are dyed and afterward varnished, but those of the natural color of the wood are only varnished, They are then stamped with the maker's name and the letters or figures which mark their hardness or softness, and packed for sale.

Chalk Pencils are made in much the same way, only different colored chalks are used instead of black-lead. The chalk is ground up with a little hot wax, and then made into strips of the right size.

Slate Pencils are thin strips of SLATE cut out and afterward rounded. The strips are sometimes cut very thin and put into wood casings like lead pencils.

The word pencil is from the Latin *penicillum*, a painter's brush, from *peniculus*, a little tail.

PENGUIN, the name of a family of web-footed birds living in the seas around the islands and coasts of the South Pacific Ocean, and especially around Cape Horn and the Cape of



King Penguin.

Good Hope. Penguins differ from other birds in having instead of wings mere flippers covered with scaly feathers, used for swimming under water, but unfit for flight. On land they stand nearly erect and waddle about clumsily, but in the water they are swift and graceful, using their wings as fins. They feed on fish and other animal food.

The Patagonian penguins, of which there are several kinds, some standing four feet high, arrange themselves when on shore, where they live only during the breeding season, in regular ranks, and in several classes: the young in one class; those sitting in another; those with full plumage in a third, etc.; one class not being allowed to intrude upon another. They look very singular as they sit upright in rows on the rocks, like files of soldiers. Their color is generally slate above and white below, with head and throat black and a yellow stripe on the side of the head. The flesh is black and fishy, but is sometimes eaten by sailors. The penguin belongs to the order *natatores*, or swimming birds.

The word penguin is probably from a native South American name.

PENNYROYAL, a fragrant herb. European pennyroyal is a kind of mint, but the common pennyroyal which grows in the United States is not a mint, though its smell is much like that of the European plant, and its uses are similar. A tea made from it is sometimes used as a medicine, especially by country people. The oil of pennyroyal is said to be good to drive away mosquitoes and flies, but this is doubtful.

The word pennyroyal is changed from *puliall royal*, which means royal flea-bane; from Latin *pulex*, a flea.

PEPPER, a kind of spice, the dried berry of a climbing shrub, which grows wild in the East Indies, but is now cultivated in most hot countries. The best pepper is brought from Malabar in India and Ceylon, and a poorer kind from Java and Sumatra. The berries are about as large as a pea, and grow in clusters of twenty or thirty, somewhat like a bunch of currants. They are first green, then turn red, and then yellow; when dried they become black and wrinkled. Each plant gives about ten pounds of pepper berries for ten or fifteen years, when a new plant is set out. Black pepper and white pepper come from the same berries. Black pepper is made by grinding the berries simply dried; white pepper is made from the same berries by soaking them in water and rubbing off the outer covering. White pepper is not so strong as black.

Cayenne Pepper, first brought from Cayenne, in South America, is made from the pod of the capsicum plant, an entirely different kind of shrub from that which bears black pepper. It grows wild in South America from Brazil to Peru. Columbus carried peppers with him on his return voyage to Spain in 1493. The pod is green at first, but bright orange or scarlet when ripe, and this gives the pepper its red color. Green capsicum is used for pickling; only the ripe dry pods are ground for pepper.

The word pepper is from the Anglo-Saxon *pipor*, Latin *piper*, pepper.

PERCH, a small fish found in both fresh and salt water. The fresh water perch is found in most of the Northern and Middle States and Canada. It is greenish yellow on the back and bright yellow on the sides, and grows ten to fifteen inches long. There is also a white perch found in some streams and ponds. Perch fishing is very pretty sport, as this fish is a quick biter and seldom nibbles at the bait. Angle-worms make good bait, but MINNOWS are also good. A small line and medium-sized pole will do to fish with.

The **Salt Water Perch** is variously called, in different parts of the United States, cunner or conner, chogset, blue perch, burgall, and nibbler. It is six to fifteen inches long, and is generally bluish brown, but is sometimes reddish or coppery, or greenish, with black spots. It is a very sweet pan fish, but is not much fished for by fishermen, who dislike it because it steals their bait when

they are after blackfish and other large fish.

The word perch is in Latin *perca*, Greek *perke*, from the Greek *perkos*, dark-colored or spotted.

PERFUMES, scents made from sweet-smelling substances. They are made chiefly from vegetables, but some from animals. Vegetable perfumes are made from flowers, such as the rose, tuberose, jasmine, and violet; from herbs, as lavender, peppermint, rosemary, and wintergreen; from certain fruits, as the orange, lemon, and bergamot; from spices, as cinnamon, cloves, and nutmeg; from various woods, as sassafras, cedar, and sandal-wood; from roots, as orris root; from seeds, as caraway, dill, and aniseseed; from gums, as camphor, myrrh, and styrax; and from certain nuts, as bitter almonds and vanilla. Perfumes from animals are MUSK, AMBERGRIS, hartshorn, etc. Besides these, there are some perfumes obtained from filthy and bad-smelling materials, such as gas-tar and the drainings of cow-houses.

Perfumes are made in many ways. Dry perfumes, such as incense and sachet powders, are simply gums, resins, dried herbs, etc., pounded or ground to powder. Liquid perfumes are mostly distilled (see ALCOHOL) from the different parts of plants. Such perfumes are called essential OILS, and sometimes ottos, from the Turkish word *attar* (see ROSE). But the perfumes made from flowers, such as are used on the handkerchief, are mostly made not by distillation, but in two other ways, called maceration (Latin *maceratio*, steeping or soaking), and absorption (Latin *absorptio*, sucking up). In the first way fresh flowers are put into hot fat or oil and left to stand a few hours, when the fat is again heated, the flowers strained out, and fresh ones put in. This is kept up for several days, when the fat will be found to be filled with the perfume of the flowers. Some flowers, such as jasmine and tuberose, are so delicate that their perfume is injured by heat, and these are treated in the second way, or by absorption. In this a layer of some kind of grease, such as beef-suet or lard, is spread over the bottom of a glass frame with wooden sides about four inches high. On this grease the fresh blossoms are laid, and the frames are then piled up one above the other, so that those on top make covers for the under ones. Fresh flowers are put in every day or two as long as the flower is in bloom, but the grease is not changed. At the end of the flower season the grease, which will be found to have taken up a great part of the scent of the flowers, is scraped off, melted, strained, and put into tin cans. Sometimes cotton cloths soaked in oil and spread over wire frames are used instead of glass frames covered with grease. When filled with the perfume, the oil is squeezed out in a press. To get the perfumes from the grease and oil the latter are put into alcohol, when all the odor goes into the spirit, leaving the grease without scent again.

The principal perfumes made in this way are the essence of rose, tuberose, orange, jasmine, violet, acacia, and jonquil; and from these, mixed in various ways, are made all the other flower perfumes: thus jasmine and orange flower mixed make sweet pea, and jasmine and tuberose, hyacinth. Most of these perfumes are made in the south of France, especially in the valley of the Var, where many acres of flowers are raised for this purpose.

The word perfume is in French *parfum*, and is from the Latin *per*, thoroughly, and *fumare*, to smoke.

PERIWINKLE, a kind of MOLLUSK living along the Atlantic coast south of Cape Cod. There are two principal kinds, but they are commonly confused under the names of periwinkle, winkle, or wrinkle north of New Jersey, and of

conch south of it. Periwinkles live in deep water, but may sometimes be seen crawling on sandy flats. They live on oysters and soft-shell clams and do great damage to the beds. Their egg-cases, called by fishermen sea-ruffle and sea-necklace, strings of 75 to 100 little disks strung together in strings a foot and a half to two feet long, may often be seen on beaches. The Indians used to eat periwinkles and to make white wampum (see MONEY) out of their shells. They made also trowels, spoons, and dippers from them, whence they are still called in some places ladle-shells.

PERSIMMON, the Indian name of a small plum-like fruit which grows wild in the southern United States, and as far north as New York. The tree, which grows to a height of 50 or 60 feet, belongs to the same family as those from which EBONY is obtained. The wood is hard and fine-grained, and is much used in turning, especially for making shuttles. The fruit is yellow and pulpy, and is sour and puckery until it has been touched by the frost, when it is very good to eat. A kind of liquor is made from persimmons in the South.

PETREL. See GULL.

PETROLEUM, or rock-oil, is found in many parts of the world. In some places it rises to the surface of the ground, but it is generally got by sinking deep holes called wells into the earth. In some wells the oil rises and flows over the top, being forced out by the natural GAS commonly found with it; but in others the oil has to be pumped out. As it comes from the earth it is a thick oily liquid of a yellowish, brownish, or greenish color. It is not known exactly how petroleum is made in the earth. At first it was thought that it came mostly from bituminous COAL, but, though some of it is made from this coal, it is now known that most petroleum comes from much older ROCKS than those in which coal is found. Some have thought, too, that petroleum is made up wholly of vegetable matter, but most writers think that it has come from both vegetables and animals. It is found in rocks of all ages, but chiefly in shales and sandstones; and it is now mostly believed that it has been made chiefly by the decay of sea plants and animals.

Petroleum has been known since the most ancient times. It was used in Greece and in Italy to burn in lamps, and also as a medicine. Herodotus, the Greek historian, tells of a spring in the island of Zante, which is still known, and which therefore has been flowing more than two thousand years. This kind of oil has been used also in India for an unknown time.

The chief places where petroleum is found are the north part of Italy; near Baku, in Persia, on the shores of the Caspian Sea; at Rangoon, Burmah; in the Caucasus Mountains; in Galicia, Austria; and in Canada and the United States. In the United States the principal places are in Pennsylvania, New York, and Ohio; but a good deal is got in West Virginia, Colorado, California, and Indiana, and some in Kentucky, Illinois, Kansas, and Texas. Nearly all produced in Pennsylvania, New York, West Virginia, and Colorado is used for illuminating purposes; and nearly all that in Ohio, California, and Indiana is used for fuel. In the oil region in Pennsylvania are many thousand wells, some more than a thousand feet deep.

Oil Wells. Oil wells are drilled by drilling-tools much like those used in making artesian WELLS. The drills, which are very heavy, are hung by a rope that goes over a wheel at the top of a high open tower of wood called a derrick, and are worked up and down by means of a small steam engine. In this way the hardest rocks can be bored through. The well is lined with wrought iron tubes,

screwed together in parts, one on top of another, and on the outside of the tube are put rings of leather with the edges cut and turned up so as to make a kind of cup around the tube. This keeps water from running down into the well.

Oil Pipe Lines. The oil from the wells flows into great tanks, from which it is carried to the shipping places, and places where it is to be refined or purified. At first it was carried by wagons over bad roads to the railway, where it was shipped in barrels or in tanks to the seaboard. In 1862 it cost $8 to send to New York one barrel of oil which sold at the wells for fifty cents. In 1865 an iron pipe, 3200 feet long, was laid from Pithole toward Oil Creek, in the Pennsylvania oil region. The teamsters were angry because they thought it would spoil their business, and often broke it, so that it was necessary to have armed watchmen to guard it. One line after another was laid, and to-day the whole oil region is covered with pipe lines, and great trunk lines have been laid to New York, Philadelphia, Baltimore, Cleveland, Buffalo, Pittsburg, and other places. The New York lines (there are two) cross the Hudson River and the East River to Long Island City, where the refineries are. Powerful pumps are used to force the oil through the pipes, and there are pumping stations, with great tanks 90 feet in diameter and 30 feet high, at about 28 miles apart.

Petroleum Products. The oil as it comes from the earth is thick and dirty, and has so bad a smell that it would be impossible to use it. It is therefore distilled (see ALCOHOL) at the refineries and separated into the different things of which it is made up. The principal of these are: Oil for burning in lamps, commonly called kerosene oil: naphtha, used in making oil-cloths, in cleaning clothes, kid gloves, etc., and sometimes as a burning fluid, although it is very dangerous; benzine, used in making paints and varnishes; gasolene, used for making gas and for mixing with coal gas; lubricating oil, or oil for greasing machinery; and paraffine, used in making candles, matches, waterproof cloths, and as a chewing gum. Many trials have been made to burn petroleum as a fuel for furnaces and for steam-engines, but they have not succeeded very well on account of the great smoke which it makes.

The word petroleum means rock oil, being made up of the Latin and Greek *petra*, rock, and the Latin *oleum*, oil.

PEWTER, an ALLOY made up of four parts of tin and one part of lead with sometimes a little ANTIMONY, copper, and zinc added. In old times all kinds of plates and dishes were made of pewter, and polished pewter-plate was kept on sideboards just as silver-plate is in these days, but it is made now only in small quantities. The chief things made out of common pewter are ale and beer mugs, syringes, beer pumps, common ink-stands, and plates for printing music. Pewter vessels are sometimes cast in iron and brass moulds and then finished in a turning lathe; but some are made by hammering out the metal, and some by spinning, as told about in METAL-WORK. Britannia metal is a kind of pewter made of tin and antimony, with a little zinc and copper. It is harder than common pewter, and is almost as white and handsome as silver. It is largely used for making coffee-pots and tea-pots, soup tureens, vegetable dishes, and other table dishes. Another kind called queen's metal is also made into table ware, and used for plating harness, carriages, furniture, etc.

The word pewter is from the Old French *peutre* or *peautre*, pewter.

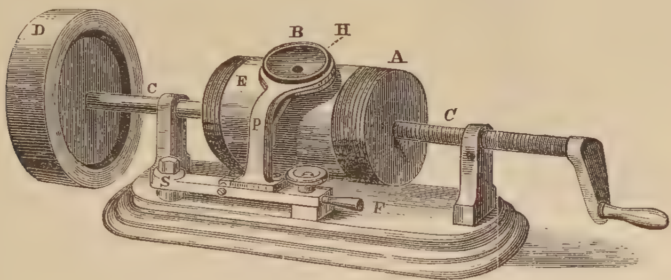
PHEASANT, the name of a family of BIRDS of the order *rasores*, or scratchers, including the pheasants proper, PEACOCKS, common fowls, and TURKEYS. The pheasants

proper mostly live in Asia, but the common pheasant is found in southern Europe, where it is much hunted. There are none in the United States.

The word pheasant is from the Latin, *Phasianus* (*avis*), the Phasian bird, from Phasis, a river in Asia Minor, whence it was first brought.

PHONOGRAPH. In the article SOUND it is told that every sound makes waves in the air, and that the striking of these waves on the drum of the ear sets the drum vibrating or trembling, and this causes the ear to hear the sound. In the article TELEPHONE is told how sound waves will make a thin plate of iron vibrate like the drum of the ear, and how these vibrations or tremblings may be carried hundreds of miles over a telegraph wire so that a person at the other end may hear the same sounds which set the iron plate trembling. Now, in the phonograph there is just such a plate as there is in the telephone, and it is set trembling by sounds in the same way; but instead of the wire to carry the sounds to a distance, as in the telephone, the phonograph has a little instrument which writes down all the vibrations of the plate and preserves them so that they may be made over again at any time; and when they are made over again, we can hear the same sounds which first caused the vibrations.

You can understand this better by

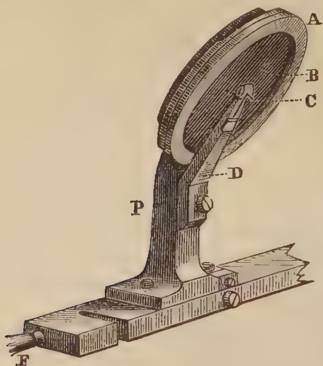


Phonograph, old Model.

looking at the picture. In this B is a mouth-piece, made like the one in the telephone. You see it is hollowed out like a funnel, and has a small round hole, H, in the middle. Under this hole is fastened the thin iron plate, so that when anyone speaks into the mouth-piece, or makes any other sound in it, the plate is set trembling by the sound waves. In the second picture is given a larger view of the mouth-piece, showing its under side. In this A is the rim of the mouth-piece, and B is the thin plate, fitted into the rim under the little hole. On the under side of the post, P, which holds up the mouth-piece, is screwed a small piece marked D (the edge of it can just be seen in the first picture), and on the end of this piece is a small steel spring with a point, C, at the end of it. This spring does not touch the plate B, but rests against a little piece of India-rubber tube, which lies close against the plate, so that whenever the plate trembles the steel point is made to tremble in just the same way.

We will now go back to the first picture, which shows the whole phonograph. Besides the mouth-piece it has a roller or barrel, A, which is made to turn round by means of the handle of the axle C C. This axle is cut round and round like a screw, as is shown in the right-hand side, so that when the handle is turned one

way it is screwed up and the barrel moved toward the left, and when turned the other way it is unscrewed and the barrel moved toward the right. A spiral or screw line is also cut all round the barrel, as is shown at the two ends, the middle part being covered up in the picture. At the left end of the axle is a heavy iron wheel, D, which is put on to make the axle turn steadily. The mouth-piece may be moved out from the barrel, or put up close to it as in the



Mouth-piece of Phonograph.

picture, by means of the handle F, the whole turning on the pin S.

Before using the phonograph a piece of tin-FOIL, E, is put round the barrel and fastened at the two ends with paste, or by putting them into a slit cut in the barrel. If now the mouth-piece be moved up close to the barrel so that the steel point on the under side of the plate shall press against the tin-foil, and the handle be then turned round, the point will press the foil into the spiral round the barrel, and as the barrel moves along sideways a dent will be made round and round the foil until it is covered all over with a mark like the spiral on the barrel. But if anybody talks or makes any other sound in the mouth-piece while the barrel is being turned round, the plate will be set trembling and the steel point will thus be made to tremble also, and instead of making a long, smooth dent around the foil, it will make a broken line of little hills and valleys just like the tremblings made in the plate by the sound waves. These dents, which look to the eye like rows of dots, are the record or marks of the sounds made in the mouth-piece; and if we could read them, they would be to us like a book in which is written down every word which we speak. Unfortunately, they all look alike to our eyes, and we cannot understand them.

But there is one way in which we can find out what they mean. Move back the mouth-piece by pulling out the handle F, turn backward the handle until the left end of the barrel is again in front of the mouth-piece, and then move up the mouth-piece until the steel point fits into the dent at its beginning. If now the barrel be turned round so that the steel point shall pass over the whole row of dents again, it will move up and down the little hills and valleys just as it did the first time; and as the tremblings of the plate first caused the steel point to make the hills and valleys, so the steel point in passing over them again will set the plate trembling again in the same way. But, you will remember, the first tremblings of the plate were caused by sounds which made sound waves in the mouth-piece; so, when the plate is made to tremble in just the same way by the steel point under it, the tremblings cause like sound waves in the air, and when the sound waves reach our ears we hear sounds much like those which first made them.

To understand this fully, let us go over it once more. Suppose that you read a page of this book to the phonograph. Hold your mouth close down to the mouth-piece, and read in a loud, clear tone, at the same time turning the handle round.

so as to move the barrel along. The sounds of your voice make sound waves which cause the plate to tremble, and the tremblings of the plate cause the steel point to write down all the sounds on the tin-foil. Next, move the barrel back and make the steel point travel over the same path again. The moving of the point over the tin-foil causes the plate to tremble again, the tremblings make the same sound waves, and the sound waves carry the sounds again to your ears, so that the phonograph talks back to you the page which you read to it. By turning back the barrel and making the point thus travel over the same path, the phonograph will repeat the same page a great many times.

The phonograph was invented in 1877 by Thomas A. Edison, of New Jersey. It aroused great interest at the time, and it was thought it could be made to reproduce exactly the sounds of the human voice, so that the words of great men and the notes of noted singers could be preserved forever; but it has proved to be little more than a toy. Attempts have been made to improve it, with some success. In 1888 Mr. Edison brought out an improved phonograph, which is much more complicated than the original one, but works on the same principles. Instead of a thin iron plate a plate of malleable glass is used in the mouth-piece, and a wax cylinder has taken the place of the tin-foil. The machine, too, is turned by a small electric motor. The wax cylinder preserves its record much better than the tin-foil, so that it may be used several thousand times without wearing out. It may, too, be packed in a box and sent by mail to be used by the receiver in another telephone.

The **Graphophone** (Greek *graphe*, writing, and *phone*, sound), called also phonograph-graphophone, is a kind of phonograph made on the same principles as that of Edison, but with more simple machinery. The record is made on a wax-covered strip of paper which is wound spirally round the cylinder. Unlike the Edison, the cylinder can be used for only one tracing. It was invented by Charles S. Taintor and Chichester A. Bell.

The **Kinetograph** (motion recorder, from Greek *kinetos*, moving, and *graphein*, to record), is an instrument combining the photographic camera and the phonograph. By means of it all the movements and gestures of a speaker or actor are recorded by the camera, while the words and other sounds of the speech or play are taken down by the phonograph. The camera makes pictures at the rate of forty-six a second, and the phonograph will make a continuous record for thirty minutes without any change of the cylinder. The photographs are taken on a long celluloid film with a row of little holes along one edge, so that it will fit exactly in the place provided for it and record the motion or gesture fitted to the words spoken at the time. The camera and phonograph are driven by the same motor. The pictures are reproduced on a screen by means of a magic lantern, the celluloid film moving in perfect time with the phonograph, so that the words of the speaker are accompanied by the proper gesture, and the picture has all the appearance of life.

The word phonograph is made up of the Greek words *phone*, sound, and *graphein*, to write or record, so that it means sound-recorder.

PHOSPHORUS, one of the non-metallic ELEMENTS. When pure it is a soft, wax-like, colorless solid. It unites so easily with oxygen that it has to be always kept under water. At the common heat of the air it gives off a white smoke, which looks bright in the dark, and the heat of the hand will make it burst into a flame. It will take fire also from rubbing, or even from cutting it with a knife. Lucifer matches take fire

when they are rubbed, because the substance on the end of the match has phosphorus in it. Phosphorus is not found free—that is, by itself alone—but is always united with something else, principally with CALCIUM. It was formerly made from calcium phosphate, got from burned bones. Growing plants take up the phosphorus from the earth, and when animals eat the plants it goes into their bones, from which it is collected for use. But it is now made chiefly from native calcium phosphate, found as a mineral in South Carolina and in the Caribbean Islands. Phosphorus unites with most of the metals and forms phosphides.

The word phosphorus means light-bringer, it being made up of the Greek *phos*, light, and *pherein*, to bring. The word phosphorescence, meaning the light given out by many sea animals and by decaying things, is from phosphorus.

PHOTOGRAPH, a picture made on paper by the action of light. Various kinds of light-pictures are made, all of which have different names. The first was the daguerreotype (named from Daguerre, a Frenchman, who found out in 1839 how to make it), a picture taken on a silver plated copper plate, but it has mostly gone out of use. What are called ferrotypes (Latin *ferrum*, iron), or tin-types, are pictures taken on thin iron plates covered with varnish. Similar pictures, called ambrotypes, are sometimes made on glass plates; but photographs have now taken the place of almost all other light-pictures. The photograph was first made by Fox Talbot, an Englishman, 1841.

Wet Process. The photograph is first made on a glass plate, and the picture is then printed on prepared paper. The glass plate is called a "negative," because the lights and shades are different from what they are in nature—that is, the light parts are dark and the dark parts light; and the paper picture printed from the negative is called a "positive," because in it the lights and shades are right, or as they are in nature. To make a negative the glass is first coated with a thin film called collodion. Collodion is made by dissolving GUN-COTTON in a mixture of ALCOHOL, ether, and some other things. It is poured quickly over the glass plate; in a short time the alcohol and ether pass off in vapor, leaving a film or skin on the plate so thin that one can see through it. The plate is next put for several minutes into a bath filled with a mixture of water and SILVER nitrate, by which a little silver is put over the collodion, so as to cover it with a thin film. If the plate be then put into the light it will soon become dark all over its surface, because light will turn silver nitrate black; but if the light be allowed to touch only a part of the plate, the other part being covered up, only the uncovered part will become dark, and the rest will not be changed. Now, in making a negative the lights and shades are made in the same way. The glass plate, covered with collodion and the film of silver nitrate, is put into a camera, a kind of dark box with a LENS in front. The camera is pointed at the object to be photographed, its cover is taken off so as to let the light in, and an exact image of the object is thrown by the lens upon the plate inside of the box. In a few seconds the camera is closed and the plate is taken out. No picture can now be seen on it, but by pouring over it an acid mixture the picture comes out little by little. This is called developing the picture. As soon as the shaded parts appear, the plate is washed, dried, and varnished on the collodion side to keep it from getting rubbed. It is then ready to use for printing positives or paper pictures.

This method of making a negative, called "wet process," was introduced in 1851 by Scott Archer, of England, and was long the only one used.

Dry Process. The wet process has now been generally superseded by the "dry-plate process," which is cheaper and easier. Dry plates coated with gelatine instead of collodion, ready for taking pictures, can be bought in packages of a dozen. They are made so sensitive that in a good light a negative can be made in the sixteenth part of a second; so that an animal running or a bird flying can easily be photographed. For taking such pictures the camera is fitted with an instantaneous shutter, which is opened and shut by touching a spring. Some negatives are made with a paper backing instead of glass for the sensitive film, and some cameras have a transparent collodion film rolled up on a wooden spool, only enough for a picture being unrolled at once. Dry plates have to be developed like wet plates, but they can be kept any length of time, and developed months after the picture has been taken. By means of them it is possible, too, to take pictures by moonlight, gas-light, and the flash light.

Printing. Photographic printing is still done in much the same way as it was by Talbot in 1841. Photograph paper is covered with a thin film of ALBUMEN, made from the white of eggs. It is bought already prepared by the photographer, who cuts it up into the sizes wanted. Before using the paper he coats it with a film of silver chloride. It must now be kept in the dark, for the light will turn it black in the same way as it will the plate. To print a picture, a piece of the paper is put under a negative, fastened tight to it with clamps, and put into the light. Now it will be remembered that in the negative the light parts are where the shades ought to be. The light, therefore, in passing through the glass upon the paper, shines more strongly through the light parts than the dark parts, so that the places on the paper which are under the light parts of the negative are turned black, while those under the dark parts of the negative are so shaded that the light does not change them much. When the picture is printed enough, the paper is taken out from under the negative and put into a mixture of water and soda, which takes out all the silver which the light has not darkened, so that light will not change it any more. The picture is now of a brownish shade, and has next to be toned or colored. This is done by putting it into a mixture of water, soda, and a little gold chloride. A part of the gold sticks to the picture and gives it a purple-black color. The picture is then carefully washed in water and dried, and afterward pasted on cardboard and finished in different ways.

Photographic pictures may be of the same size, larger, or smaller than that from which they are taken. During the siege of Paris by the Germans large newspapers were photographed on very small pieces of paper and sent by carrier pigeons into the city, where they were photographed large again, so as to be easily read. Photography is now applied to many different uses. By means of the telescope pictures of the heavenly bodies have been obtained, showing many things invisible to the naked eye. In hospitals curious and interesting cases are photographed so as to preserve a record of them, and in police stations the faces and sometimes even the hands of criminals are taken for a similar reason. Artists, too, make great use of the camera to get accurately the motions of human beings, horses, and other animals. There are now in the United States many societies of amateur photographers, who take great pleasure in making pictures wherever they travel.

Printing Processes. Common photographic prints cannot be expected to last always, so many methods or processes have been devised to make permanent pictures. Some of these are chemical and some

mechanical. In the latter prints are made in lithographer's or printer's ink from the negatives or from electrotype plates made from them. These processes are known by different names, such as autotype, heliotype, phototype, photo-engraving, photo-relief, heliogravure, photogravure, etc., all of which are too complicated to be told about here. Photographic printing can now be done on silk, satin, cotton, wall-paper, etc.

Photography in Colors. Many attempts have been made since photography was invented to find out some way of making pictures with their natural colors. It is believed that this will be done in time, but no one has succeeded in doing it yet. In 1890 an Englishman named Bond succeeded in making plates sensitive to yellow, blue, and red, and in 1891 Prof. Lippman of Paris succeeded in reproducing the colors of the solar spectrum (see LIGHT); but in both cases the plates had to be exposed so long a time as to make the discovery of little value.

The word photograph means light-picture, it being made up of the Greek words *phos*, light, and *graphein*, to write or paint.

PIANOFORTE, the full name of the musical instrument commonly called piano. The piano grew out of the harp, and if you look at the strings of a piano you will see that they are still arranged in the form of a harp. The first instrument made like a piano was the clavichord, which was invented in Italy in the fourteenth century. This was oblong, like the square piano, and had strings of catgut. The clavichord was superseded in the fifteenth century by the virginal, an instrument on which Queen Elizabeth and the ladies of her court played, and this again by the spinet. Both the virginal and the spinet had strings of wire and catgut, but had only one string to each note, and only four octaves. About the end of the fifteenth century the harpsichord was first made in Italy. This instrument, which was shaped like our grand pianoforte, was really a horizontal harp played by means of keys with jacks and quills that pulled the strings instead of striking them as the hammers do in the piano. About the beginning of the eighteenth century (1709) Bartolommeo Cristofori (not Christophali, as often written), a harpsichord maker of Padua, introduced hammers into the harpsichord, and thus made the first pianoforte. This improvement was long in coming into use, and was not known in England until about 1757. Until 1760 all pianos were made in the form of the grand piano, but in that year the first square piano was made in London. The first piano made in America was manufactured in Philadelphia in 1775 by John Behrent.

The piano is now made in three principal forms—the grand, the square, and the upright. In grand and square pianos the strings are horizontal, or on a level, but in upright they run up and down. There are three sizes of grand pianos: a large size called "concert grands," fitted for playing in concerts; a middle size called "semi-grands," for large rooms; and a smaller size called "parlor grands," for playing in parlors. Square pianos, which are not square, but oblong, are usually made in two sizes, those of the larger size being called "grand squares."

The piano is made up of four parts: 1. The frame. 2. The strings. 3. The keys and action. 4. The case.

1. The **Frame** is the heavy iron part on which the strings are stretched. The strings have to be stretched so tight that there is a great strain on the frame (about 25,000 pounds in a grand piano), and unless it is made very strong the piano will not keep in tune. In former times, when pianos were small, the frame was made of strong timber, but it is now made of one piece of cast iron, for wood could not stand

the strain in the large pianos of the present day.

2. The **Strings.** In the first pianos strings of steel wire were used for the upper notes and brass wire for the lower ones, but in modern pianos the strings are all of steel wire. The different tones are made by having the wires of different sizes and lengths. The longer and larger a wire is the lower its tone will be; but as a piano is too short to put in wires of the common size which will be long enough to make the lowest bass notes, the wires have to be made larger by winding fine wire around them. This fine wire is sometimes of soft iron and sometimes of copper. In the old spinet there was but one string for each note; in the harpsichord there were two, but in all large pianos there are three. The tone of the strings is much improved by the sounding-board, a large thin board without any knots in it, made usually of American spruce wood, which is put under the whole row of strings. It is fastened to the frame by its edges only, so as to leave the whole middle part of it free to vibrate or tremble when the strings sound above it.

3. **Keys and Action.** The row of keys in a piano is called the keyboard. In the square piano the keyboard is on the side, but in the grand piano on the end. The white keys are usually made of cherry wood, covered with a thin slip of ivory, but sometimes with MOTHER-OF-PEARL. The black keys are sometimes made of ebony, but commonly of cherry wood stained black. All the moving part between the keys and the strings is called the "action." When a piano key is pressed down by the finger, a little piece of wood with a head covered with thick felt is made to jump up and strike the strings. This, which is called from its shape the hammer, is what causes the sound. If the key be held down the sound will continue, and be clear and open, but if the finger be taken off so as to let the key rise up, the sound will be softened and muffled so that it will nearly cease. This is because a small piece of leather, called the damper, which sits on the top of each string, is raised off the string when the key is pressed down; and as soon as the finger is taken off the key, the damper falls into its place again and damps the sound by stopping the vibration or trembling of the string. When the loud pedal of a piano is pressed down by the foot, the whole row of dampers is raised up from the strings, so that the sounds of all are made loud, clear, and ringing. The soft pedal damps all the strings, so as to soften the sound. There are many different kinds of actions, some of which are simple, while others are very hard to understand.

4. The **Case** of the piano includes the box, which holds the frame, strings, and other parts, and the legs on which it stands. All this is cabinet work, and is made of different kinds of wood, which must be well dried and seasoned before using. The best pianoforte makers have large lumber sheds, in which the wood for cases is kept stored up for several years. Some cases are made of solid walnut, mahogany, or other woods, but most of them are made of some common wood and covered with VENEERS.

It takes at least six months to make a good piano, as the parts have to be put together very carefully. The different parts are made by different workmen, as many as forty persons being employed on a grand piano.

The word pianforte is from the Italian *piano*, soft, and *forte*, loud, and the instrument is so called because it can be played either soft or loud.

PICKEREL. See PIKE.

PICKLES, vegetables, fruits, and other things preserved in vinegar for eating. The vegetables most commonly used for pickling are small cucumbers, onions, cabbage, cauli-

flower, string beans, and beets; the fruits most used are olives, peaches, cherries, mangoes, and several kinds of melons and unripe nuts. The things to be pickled are first soaked for a few days in strong brine made of salt and water, then packed into the vessels prepared for them; a few peppercorns or other spices are put in with them, and boiling vinegar is poured in until the vessel is quite full, when it is tightly covered. Makers of pickles often boil their vinegar in copper or brass kettles, which gives the pickles a rich green color, but this should never be done, as the vinegar thus forms an acetate of copper, which is very poisonous. Therefore pickles of a brighter green than the vegetables themselves should never be eaten.

Of foreign pickles the most important are OLIVES, which come pickled both in brine and in vinegar, CAPERS, MANGOES, and bamboo shoots. Chow-chow (Chinese, meaning mixed) is a mixture of various kinds of pickles.

Several kinds of fish, shellfish, and meat are also preserved in brine, but they are not generally called pickles.

The word pickle is in German *pökel*, pickle or brine. Its origin is uncertain.

PIGEON. Pigeons are found in almost all parts of the world, but mostly in warm countries. They generally roost and build their nests in trees. Their wings are strong, so that they can fly great distances, and they often go in immense flocks. They lay usually but two eggs at a time, and wild ones breed but once a year, but tame ones will lay and hatch seven or eight times in a year. Pigeons live together in pairs, and both parents sit by turns. Their young are fed, until they are able to fly, with a milky fluid which males and females raise from the crop. Pigeons do not drink like * others birds, but take a long draught without raising the head.

There are many kinds of pigeons, but only two kinds, the common pigeon and the turtle-dove, have been tamed. All the fancy breeds now raised came from the common pigeon, which is descended from the wild rock-pigeon or rock-dove. The rock-pigeon is found along the coasts of Europe, Asia, and Africa, where it breeds in holes in the rocks or in caves opening on the sea, but never lives in woods nor builds its nests in trees, like most other pigeons. The common pigeon, too, likes best to make its nest in a dovecot or in the loft of a building, where it can hide away in the dark.

Common pigeons are generally white, slate color, light brown, or a mixture of these colors. They are easily raised, need but little care, and increase very fast. They are sometimes fed, and may be taught to come to their meals at the sound of a whistle, but they commonly fly round the neighborhood and pick up their food where they please. They seldom go a great way from their home, but sometimes will leave and go to the woods, where they become wild again. Fancy pigeons do not do this, but will usually join some other flock of tame ones if they get lost or are moved from their home. Among the principal fancy pigeons are those called fantails, tumblers, pouters, runts, jacobins, nuns, and carrier-pigeons.

Fantail Pigeons are so-called because they have a way of spreading their tails out like a fan, in much the same way as the peacock, bending it so far over the back that the feathers often touch the head. Their tails sometimes have a trembling motion, from which they get the second name of shakers. There are two kinds of fantails, the broad-tailed and the narrow-tailed. Their feathers are generally white, but in some they are reddish-brown, slate color, or cream color. These are very pretty birds, but are of little value except as curiosities.

Tumbler Pigeons get their name from their habit of turning over or tumbling in the air. When starting to fly upward they generally turn five or six somersaults, and when high up in the air, where they will stay for several hours at a time, they may often be seen in flocks tumbling and playing in a very amusing way. There are several kinds of tumblers, but the "bald-pated tumbler," named from its snow-white head, which looks bald, is the best.

Pouters are so called from the form of their crop, which the bird can fill with air until it swells up almost as large as the body, hiding the head and neck. They have then a comical appearance, looking much like a large round ball, with long feathered legs and a slim tail below it. These birds are very hard to raise, and are not worth much excepting as curiosities. They are of different colors—black, slate color, light brown, and yellow, pied with white.

Runts are short, full-breasted birds, with a long thick neck, and with the tail slightly turned up. The feathers are generally grizzled—that is, black and white mixed, but some have black, white, or reddish-brown feathers. In the Friesland runt the feathers stick out the wrong way, giving it an odd look.

Jacobins have a ruff of raised feathers on the back part of the head, forming a kind of hood or cowl like that of a monk. The name is from Jacobus, the Latin for James, and was given to the Dominican monks of Saint James in Paris. Jacobin pigeons are small, but pretty in form. Some are pure white, but generally the back, breast, and hood are reddish-brown, and the head, wings, and tail white. This pigeon stays much at home, its hood keeping it from flying very far.

Nuns have their heads almost covered with a veil of feathers, from which they get their name. The body is mostly white, and the head, tail, and part of the wings generally reddish, yellow, or black. This pigeon is small, but is very neat and pretty.

The **Trumpeter** is named from the sound it makes, which is thought to be somewhat like the tone of a trumpet. It has feathered legs, a ruff on its neck, and a tuft of feathers sprouting from the base or upper part of the bill. The larger this tuft is, the more the bird is prized.

The **Carrier-Pigeon** is larger than the common pigeon, and is longer and slimmer in the body. Its neck is long and slim, and it has a piece of naked skin across its bill and hanging down on each side. The best ones have also a wide circle round the eyes, bare of feathers. The wings are strong, and these birds will fly very fast for great distances. They are noted for their love of home, and they will always find their way back even when taken hundreds of miles away. For this reason they have been used from the most ancient times, especially in the East, for carrying letters, and it is from this that they get their name. Sailors used to carry pigeons on their voyages and set them free when they reached the port they were going to, in order that they might carry home the news of their safe arrival. The Romans used them to carry news in and out of besieged towns. The Prince of Orange used them in the same way at the siege of Leyden (1574); they were also used by the French during the siege of Paris by the Germans (1870–71), thousands of letters and even newspapers, photographed on small thin films, being sent in and out of the city. It is said that 150,000 official dispatches and a million private ones were thus sent in, which, if printed in ordinary letters, would have filled 500 volumes.

There are several kinds of carrier-pigeons, all of which are descended from the Persian pigeon mixed with the common pigeon. The Persian pigeon (Fig. 1) was used in early times by the Caliphs of Bagdad to

carry messages between that city and Cairo, and is therefore often called Bagdad pigeon. It is marked by a

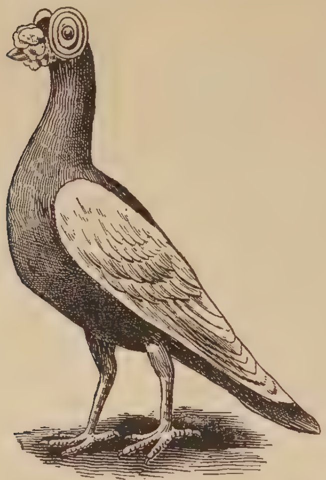


Fig. 1.—Persian Pigeon.

fleshy skin at the base of the beak and by a large circle around the eyes. The cravatted pigeon (Fig. 2)

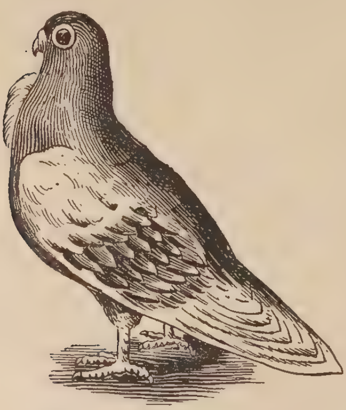


Fig. 2.—Cravatted Pigeon.

has a very short beak and a tuft of feathers on the neck somewhat like the knot of a cravat. The Antwerp pigeon (Fig. 3) has a long body and wings which extend almost to the end of the tail. This is the pigeon adopted by the German military authorities for use in the army. It is very swift and bears fatigue well. The French prefer the Liége pigeon (Fig. 4), which is noted for its energy, courage, and tenacity. Not only the Germans and French, but the Spanish, Portuguese, Italians, Austrians, and Russians have now a military pigeon service. Dove cotes are kept in the principal cities and fortresses, where, under direction of officers of the engineer corps, pigeons are regularly trained. Belgium has no pigeon service, but fanciers there

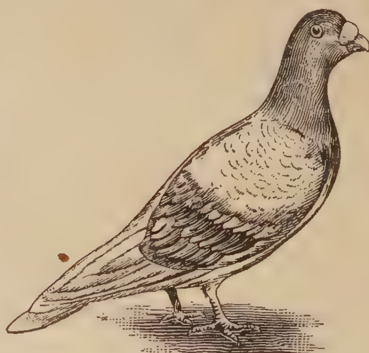


Fig. 3.—Antwerp Pigeon.

own 600,000 racing pigeons, all of which could be used by the government in case of war.

The training of carrier-pigeons begins as soon as they are strong enough to fly. The young birds are taken in a covered basket to a place about a half mile from their home and set free. Those which do not go home are considered worthless; those which do go home at once are tried again, the distance being increased each time, until it is found that they will go back no matter how far away they are carried. The letter is usually written on very thin paper and tied around the upper

part of the leg. Carrier-pigeons will fly at least thirty miles an hour, and some have been known to go twice and even three times as fast. The Chinese fasten whistles to pigeons' tails, which make an unearthly noise as they fly through the air. Some of these are made of bamboo scraped very thin, and some of quill. Some books say those whistles are put on to frighten away falcons, which often pursue and kill carrier-pigeons, but it is probably only for amusement.

The **Wild Pigeon** of the United States is the passenger pigeon. These birds are found in the western and southwestern States in great numbers. Their roosting and breeding places often cover many square miles of forest, every tree being filled with nests wherever a place can be found for them. Sometimes they fly in such vast flocks that they hide the sun, and the noise of their wings is like the roar of the wind. An old farmer, who once heard a great flock flying through the woods, said they made more noise than ten thousand threshing machines.

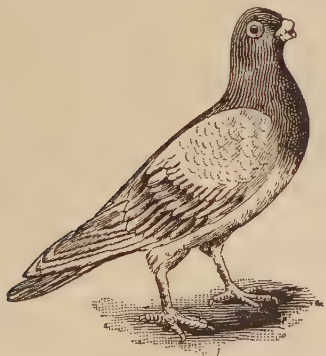


Fig. 4.—Liége Pigeon.

Audubon says that these pigeons travel a mile a minute, and their eyes are so sharp that as they fly over the country they can tell at a glance whether it is barren or has in it the kind of food they want. They do not go from one part of the country to another to find a warmer climate, but only in search of BEECH nuts and ACORNS, which are their principal food. They often fly hundreds of miles in a day to feed, going back to their roosts at night. Sometimes they light on the trees in such numbers that the branches are broken down and many pigeons crushed. Great numbers are killed every season for market, their flesh, which is brown, being much liked for food. Many young pigeons, or squabs, as they are called, are taken alive. When they are nearly old enough to fly, men go to their roosts armed with long poles, with which they upset their nests; the poor squabs tumble out and are caught in great numbers. They can then be put into cages, fattened, and killed as they are wanted.

The pigeon belongs to the order *rasores*, or scratching BIRDS.

The word pigeon is in French *pigeon*, which is from the Old French *pipion*, Latin *pipio*, a young, chirping bird; from Latin *pipire*, to peep.

PIKE, the common name of a family of fresh water fishes belonging mostly in North America; only one kind being found in Europe. The great lake pike, caught in the northern lakes is brown, green, or black, marked on the sides with long white blotches, and seldom weighs more than 12 pounds. It is the same as the pike of England, where it is considered one of the most important of game fishes. Around the great lakes the Indians catch it through holes in the ice, as it takes bait more readily in winter than other fish. Pike are strong fish, rapid swimmers, and very greedy, living mostly on other fish. A large pike will run down a smaller fish just as a greyhound runs down a hare. No matter how the frightened little fish may turn and bend, now swimming among the weeds in hope of finding a hiding-place, now darting through a shoal of other fish in hope of being

lost sight of, its big and savage foe is not to be deceived. The pike follows it surely and steadily, until at last, tired out, it falls into his gaping jaws, and he then swims away to his lair to eat his prey at his ease.

The **Maskalange,** muscallonge, or maskinonge is a larger kind, often weighing 20 to 40 pounds. It is nearly black on the back, with bluish-gray sides marked with brown, and grayish white below. Though not as plentiful as the common pike, it is caught in all the great lakes and in Lake Champlain. Its flesh is better than that of the pike. It is called maskanonge in the laws of Canada; its name is said to be in the Chippeway Indian dialect from *mas*, great, and *kinonge*, pike.

The **Pickerel** (pike-rel, small pike) is found in the streams and lakes of the Atlantic coast from Maine to Alabama. It is not found in the lake region, nor west of the Alleghanies. In the southern States it is commonly called the jack. The pickerel sometimes reaches seven or eight pounds, but is usually much smaller. Its flesh is white and of good flavor.

The pike is so called from its sharp nose, which is like a pike or spear.

PILE, a pointed log of wood, which is driven into the earth to make a foundation to build upon, a dam in water, etc. Piles are generally used in loose soil, through which they are driven till they reach a hard bottom. They thus make a safe and firm foundation for buildings, roads, wharves, and bridges. Coffer-DAMS are sometimes built by driving rows of piles in circles and packing clay between them. Piles are driven into the ground by machines called pile-drivers, worked usually by steam. A heavy weight is raised up between two tall posts and let fall from the top on to the pile, which it thus drives in by blow after blow.

Some piles are made of iron and cast hollow; and some have screws at the bottom, instead of points, by means of which they are screwed into the ground.

The word pile is from the Anglo-Saxon *pîl*, sharp stake, which is from the Latin *pilum*, a javelin.

PIMENTO. See ALLSPICE.

PIN. Pins were formerly made by hand, and the heads were put on separately and welded on while hot by blows of a hammer; but they are now made mostly by machines which produce them solid-headed. Some pins are still made by hand in England, but none in the United States. The pin machine, which is an American invention, makes the whole pin without any help from the workman, who is thus able to attend to several of them at a time. The brass wire, which is of just the thickness of the pins to be made, is rolled up on a reel at the back of the machine. A pair of nippers takes hold of the end of the wire and draws in enough to make one pin. This is cut off and carried to the pointing wheel, where it is sharpened. A finer wheel then finishes the point, and the pin is next carried to the heading DIE, where a steel punch jams down the end and partly makes the head. Another die and punch finish the head, and the completed pin drops into a box. The machine goes on thus making pin after pin, at the rate of three or four every second of time, until all the wire on the reel is used up, when another reel of wire is put in its place.

The pins, which are of the color of brass when they come from the machine, are brightened in a barrel of saw-dust which is made to turn round very fast. They are next boiled for about three hours in copper kettles in weak NITRIC ACID in which are pieces of tin. This covers them with a thin coating of tin, and they are then rolled again in a barrel of saw-dust to polish them. Lastly, they are stuck on papers by

another machine, which puts one row on at a time. All this machine needs is a supply of paper and pins and it will do all the work without any help. Black pins are made by boiling brass pins in japan varnish instead of with tin.

Pins like those now used were not known in ancient times. Even in England, up to about the middle of the sixteenth century, people fastened their dresses with thorns, and with bone, ivory, and wooden skewers; but the rich sometimes had gold and silver ones. Pins were first brought into England from France by Catherine Howard, fifth queen of Henry VIII. They were so expensive that for a long time they were used by rich ladies only, and it became customary to give a certain sum to women at their marriage for buying pins, which sum was thence called "pin-money."

The word pin is found in many languages, and is perhaps from the Latin *pinna*, a pinnacle or small steeple.

PINCERS, or **PINCHERS,** are small instruments made for seizing things to be held fast, for drawing

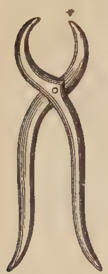


Fig. 1. Blacksmith's Pincers.

Fig. 2. Shoemaker's Pincers.

Fig. 3. Nippers.

out nails, and for other uses. Blacksmiths have several kinds for holding pieces of iron while heating them in the fire and when hammering them on the anvil. Carpenters, shoemakers, and other mechanics also have different kinds. In the pictures Fig. 1 is a kind used by blacksmiths and farriers, and Fig. 2 by shoemakers. In Fig. 3 is shown a kind of pincers commonly called nippers, used by carpenters and others for

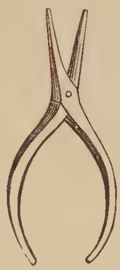


Fig. 4. Pliers.

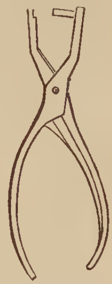


Fig. 5. Punch Pliers.

cutting wire, nipping off small nails, or for holding things. Pliers, Fig. 4, are small pincers by which any small thing, such as wires and thin pieces of metal, may be seized and bent. Another form, Fig. 5, called punch-pliers, has a hollow sharp-edged steel punch on one of the jaws, so that when it is pressed down on the other jaw it will punch a hole in leather, paper, etc. Punch-pliers are used by shoemakers to make holes in shoes for the shoe-strings, by harness-makers for cutting holes in straps for buckles, and by railroad conductors for punching tickets.

The word pincers is from the French *pincer*, to pinch.

PINE, the name of a family of cone-bearing trees found in Europe, Asia, and America. Pines are marked by their leaves, which are needle-shaped, and which grow in clusters of two to five, with little scales at their base. Most of the pines are found in cool countries, some even in the Arctic regions. The principal pines in the United States are the white and the yellow pine.

The **White Pine,** which grows in Canada, the northern and middle

United States, and as far south as Georgia, is one of the largest of forest trees, being often more than twice as high as a four-story house (130 to 150 feet); and some have been cut which were much more than two hundred feet high. From this tree, which is soft and easily worked, comes most of the lumber or wood used for woodwork on the inside of houses, and it is also used for the frames of buildings, for the timbers of bridges, the masts and spars of ships, and many other purposes.

The **Yellow Pine,** called also the pitch pine, grows along the Atlantic coast from North Carolina southward, and in the Gulf States to Texas. It is very abundant in Georgia, and is often called Georgia pine. It seldom grows on the Atlantic coast more than seventy-five feet high, but in the Gulf States reaches 90 to 100 feet. Yellow pine timber is harder and tougher than white pine, and is much used in ship-building, for making floors, and many other things. From this tree is made the greater part of the turpentine, resin, tar, and pitch used in the United States. An oil called "dead oil," having great preservative qualities, is made by distilling (see ALCOHOL) the wood, and a kind of material called "pine wool" is made from its leaves, and used in the manufacture of rugs, baling stuffs, etc.

The yellow pine of California (*Pinus ponderosa*) is a much larger tree, nearly as large as the sugar pine. It grows on the Pacific coast west of the Rocky Mountains from New Mexico to British Columbia. Its trunk reaches a height of 150 to 200 feet and sometimes even 300, and a diameter of six or seven feet.

The **Sugar Pine** of the Rocky Mountains grows sometimes three hundred feet high, or higher than a church steeple. Its wood is much like that of the white pine. The resin which oozes out of it when partly burned is sweet, and is used by the Indians for sugar. The seeds of the tree are also eaten by them, either roasted or pounded and made into cakes.

The **Nut Pine,** which grows in northern Mexico, New Mexico, and Arizona, has large edible seeds called by the Mexicans *piñones*, which are sold just as peanuts are with us. The tree is seldom more than thirty feet high. The common pine of Lower California also furnishes edible nuts. The seeds are good when fresh, but are more digestible when roasted. As soon as the cones begin to open the Indians assemble and camp among the pine trees for the yearly harvest and feast. The women pluck the cones from the trees in nets which when full are let down by a string, emptied, and drawn up again, and the children gather those on the ground. The cones are thrown on to hot ashes to open them, when the seeds are removed and roasted in an earthen pot over a slow fire until the hull is parched, when it is easily removed from the kernel. The Indians eat great quantities of pine nuts, and grow very fat during the harvest. They also make bread and mush of them.

The word pine is from the Latin *pinus*, pine.

PINEAPPLE, the FRUIT of the pineapple plant, which first grew in South and Central America and Mexico. It was carried to Asia and Africa by Europeans, and is now found in most hot countries. The pineapple plant has many long, stiff, sharp-pointed leaves, from the middle of which grows a short stem bearing a single fruit. Pineapples are sent from the West Indies to all parts of the world, and are much valued as a fruit for dessert and for preserving. The juice is used for flavoring ices, soda-water, and other things, and in some countries a liquor called pineapple rum is made out of it. The leaves of the plant have in them fine fibres or threads

from which are made the beautiful goods called *pina* or pineapple cloth. This is largely manufactured in the Philippine Islands. In China it is woven into linen, and in India bags and pouches are made of it. Cordage and nets are also made from this fibre.

The juice of the wild pineapple is said to be so sour and sharp that it will take the skin off the lips and gums, and it is only when cultivated that the fruit is good to eat. Great numbers of fine pineapples are raised in England in glass hot-houses, and the fruit thus grown is said to be better than that brought from hot countries.

The word pineapple is made up of pine and apple. The fruit is called by the Spaniards *pinas*, because it looks like a pine cone. The Brazilian name is *nana*, which the Portuguese turned into *ananas*.

PIPE, a bowl and tube for smoking TOBACCO. Tobacco pipes are made of many different things, such as baked clay, porcelain, glass, stone, meerschaum, wood, and various metals. Common clay pipes are made of a kind of white clay, called pipe-clay, found chiefly in Dorsetshire and Devonshire, England, but also in France, Belgium, and Germany, where pipes are largely made. The clay is first ground and carefully purified. Children, who are trained to the work, roll out little lumps of it on a table into long rolls of the size of a pipe stem. A lump of clay large

Fig. 1.—Boring the Stem.

enough to make a bowl is then stuck on to the end of each roll, and in this state they are laid on boards to dry. When dry enough the pipe moulder takes a long sharp wire, which has a wooden handle, and runs it carefully through the whole length of each stem, as shown in the picture (Fig. 1). The roll of clay, with the

Fig. 2.—Shaping the Bowl.

wire in it, is next laid into the half of a copper or brass mould (Fig. 2), which has another half that can be fitted to it exactly by means of pins put through the little holes. The mould is now placed in an iron frame (Fig. 3) and screwed up tightly together. The bowl is made by forcing into the mould the plug (Fig. 4), which is shown in place in Fig. 3. By pushing the wire a little further, until it touches the plug, the hole is made entirely through the pipe.

Ornaments and letters to be made on the pipe are cut into the mould, and are thus pressed into the clay.

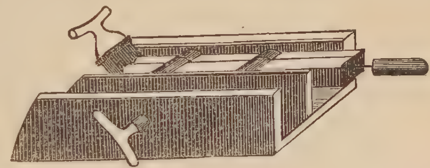


Fig. 3.—Boring the Bowl.

After the pipe has been dried for a time it is baked in a kiln with many others. A man can make about five hundred such pipes in a day.

The pipes most valued by smokers are those made of *meerschaum* (sea-foam, from German *meer*, the sea, and *schaum*, foam), a soft white mineral which looks something like chalk. Most of the meerschaum comes from Asia Minor, near the town of Konieh, where it is dug from the earth. It is sent to other countries either in rough blocks or in

partly shaped pipe bowls, which are afterward finished by workmen skilled in the business. A large number are made in Vienna and

Fig. 4.—The Plug.

Pesth, and some in New York and other cities. Some are very beautifully carved. The parings are ground up, mixed with water, and moulded into blocks from which a cheaper kind of pipe bowls called *massa-bowls* are made.

The Germans make pipe bowls of porcelain, which are finely painted and ornamented. The pipes of the Turks, Persians, and other Eastern nations are sometimes very beautiful and expensive. One kind, called

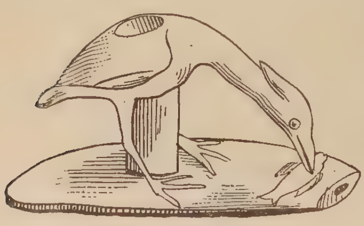


Fig. 5.—Bird Pipe.

a *chibouk*, has an earthenware bowl, a long cherry stem, and an amber mouth-piece. Other kinds, called *hookahs* and *nargiles* or *nargilehs*, are very large, with long flexible stems, and are so made that the tobacco smoke is drawn through water to cool it.

Pipe-stems are made of cane, and of cherry, elder, mock-orange, jasmine, and other woods. Great numbers of cherry stems are made in Austria. Mouth-pieces are usually made of ivory or amber, but sometimes of gold and silver. A great deal of amber is used for making mouth-pieces for pipes and cigar-holders, and some are very costly.

Indian Pipes. The American Indians made pipes, long before the coming of the whites, out of a kind of red stone which they got from a quarry in Minnesota, near the south-west corner of the State. The stone, which is blood-red and soft enough to be easily cut, was greatly valued by them, and carried from the quarry all over the country from the Atlantic to the Rocky Mountains and south to the Gulf of Mexico. The first white man even permitted to visit

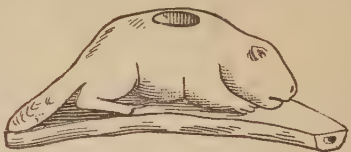


Fig. 6.—Beaver Pipe.

the place was George Catlin, the famous painter of the Indians, and from him the stone, which is a new kind of mineral, has been named Catlinite. The quarry is told about by Longfellow in "Hiawatha." A great many curiously carved pipes made of this stone have been found in Indian tombs and may now be seen in museums. The calumet, or pipe of peace, smoked by the

Fig. 7.—Elephant Pipe.

Indians on all great occasions, had a head of this stone and a long stem adorned with birds' feathers. Pipes were carved in many different forms,

representing beasts, birds, fishes, and even men's heads. Several elephant pipes have been found showing the animal's trunk but not his tusks. Some think from this that the mound-builders lived when the elephant existed in America. The pictures (Figs. 5, 6, and 7) show a heron (eating a fish) pipe, a beaver pipe, and an elephant pipe.

The word pipe is Anglo-Saxon, meaning a tube.

PISTACHIO, the fruit or nut of the pistachio tree, which grows wild in Syria. The tree, which grows 20 to 30 feet high, is cultivated all around the Mediterranean. Pliny says it was taken to Italy by Vitellius at the end of the reign of Tiberius, and thence to Spain by Flavius Pompeius. The fruit, which is about the size and shape of an olive, has a greenish kernel of an almond-like taste, much liked by the Greeks and Turks as a dessert nut. In Europe pistachio nuts are candied and sugared, but in this country they are used chiefly by confectioners to color ices and similar things green. They yield also a good food oil, somewhat like almond oil.

Pistachio is from the Latin *pistacium*, Greek *pistakion*, the pistachio nut.

PISTOL, a small firearm to be used with one hand. Pistols came into use soon after muskets. At first they were made with but one barrel, but another barrel was soon added. Revolving pistols were made at an early period, but they did not come into use. In 1836 Samuel Colt first made the pistol which is named after him, and since that time others have made revolving pistols, but they are all much like his. The Colt pistol is now used by the United States navy and by the cavalry. It has but one barrel, behind which is a cylinder bored usually with six chambers or holes, each of the same size round as that of the barrel; but the number of chambers may be more or less than six. The chambers are loaded with metal cartridges, containing the powder, ball, and percussion powder, much like those used in the Springfield RIFLE. The Remington and the Smith & Wesson revolving pistols differ but little from Colt's and use the same kind of cartridge. The Smith & Wesson pistol is used by the Russian army. The pistol used in the British army is called the Adams; it is made in England, but it is much like the Colt pistol. Other European armies are armed mostly with pistols made in France and Belgium.

The Colt armory in Hartford, Connecticut, is one of the largest in the world, and can make more than a thousand firearms in a day. On the grounds, which cover about 250 acres, are, besides the workshops and offices, many houses for the workmen, a fine church, and other buildings. All the ornaments of one of the main doors of the church are made up of the parts of pistols put together in different ways. The work is so neatly done, and looks so well, that one would not see the pistols unless they were pointed out. This doorway is called the Armorers' Porch.

The word pistol is said to be from Pistoja, Italy, where pistols were first made. The name was first given to a kind of dagger made there.

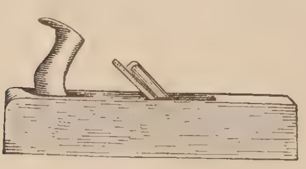
PLAICE, a flatfish of the same family with the sole, the flounder, and the halibut. It is found on our Atlantic and Pacific coasts, in China and Japan, and in the Indian Ocean, but not in Europe. It is called plaice about Cape Cod and on the eastern coast of Connecticut and Long Island, where many are caught; but it is called also common flounder, summer flounder, and deep-sea flounder, and in Rhode Island brail and pucker-mouth. The plaice averages in length 16 to 30 inches, and in weight two and a half to eight pounds, though some of more than 20 pounds have been caught.

It is found generally on sandy bottoms at a depth of 10 to 20 fathoms. Great numbers are caught in seines and weirs, and many by hook and line with squid or clam bait.

PLANE. This tool, in its most simple form, is only a CHISEL set at a slant into a kind of box called the stock, with the cutting edge coming through the bottom just far enough to cut a thin shaving from the wood over which it is passed. If a man tried to smooth a board with a chisel, he would have to hold the tool very firmly in his hand and keep it at just the same slant all the time. This he would find almost impossible to do, because any twist in the grain of the wood or any knot would be apt to turn the edge aside. But when the blade is fixed tightly in a box, as in the plane, it is guided and cannot slip aside.

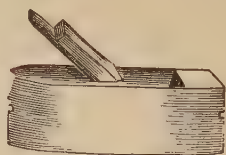
Such a plane, however, would be hard to use, because the shaving which it cuts is long and presses against the plane-iron in coming up through the hole in the stock. Another iron, called a back-iron, is therefore put on top of the chisel blade, the object of which is to turn up the shaving as fast as it is cut and break it, so that it cannot press so tightly as it comes through. If you look at a shaving from a plane, you will see that it is broken across in little pieces in its whole length.

Three kinds of planes are commonly used by carpenters and joiners, the jack-plane, the trying-plane,



Jack Plane.

and the smoothing-plane. The jack-plane, the form of which is shown in the picture, is generally about fifteen inches long. Its use is to cut off from the surface of boards the rough marks made by the saw. Its edge is a little curved, so that it does not cut exactly level, but makes little valleys all over the surface. The trying-plane, generally about two feet long, looks much like the jack-plane, but has a straight edge, and is used after the jack-plane, to shave down all the lines between the valleys so as to make the surface even. The shavings cut by the trying-plane are smoother than those which come from the jack-plane. The smoothing-plane, the shape of



Smoothing Plane.

which is shown in the picture, is much shorter than the others. It is used after the trying plane, to shave off any small twists, curls, or other rough places which may be left.

There are many other forms of planes used by carpenters and joiners, with blades made in different shapes for cutting uneven surfaces, such as mouldings for doors and window-frames, picture-frames, etc. Planes much like these now in use were used by the ancient Romans. Some made of bronze have been dug up from ruins in Britain.

The **Planing Machine,** or wood-planer, is a machine for smoothing the surface of planks, beams, and other large pieces of wood. Some planing machines plane the top, bottom, and edges of a board at once, and do it very rapidly. A similar machine, called also a metal-planer, is used for smoothing the surface of metals.

The word plane is from the Latin *planus*, level, and the tool is so called because it is used to make surfaces level or even.

PLANE TREE, the name of the tree commonly called buttonball or buttonwood in the United States, and sometimes sycamore. It grows almost all over the United States east of the Rocky Mountains. It is frequently more than 100 feet high, 12 to 15 feet thick, and makes an excellent shade tree. Its wood is hard and close-grained. In the East it is used for ship-building and for joiners' work, but it is not much used in this country. The buttonballs, which are the fruit of the tree, are made up of a single seed covered with bristly down.

The plane tree gets its name from the Latin *platanus*, Greek *platanos*, plane tree; from *platus*, broad; its top being broad and spreading.

PLANTAIN. See BANANA.

PLANTS. Plants make up the vegetable kingdom, just as ANIMALS form the animal kingdom, and ROCKS the mineral kingdom (see ELEMENT). Plants are found on nearly all parts of the surface of the earth, both on dry land and in the water, but no two countries have exactly the same kinds. All the plants growing in any country are commonly called the flora of such country. Plants grow best in hot and damp countries, and generally grow smaller, both in size and in number of kinds, as we go from the equator toward the poles or cold parts of the earth; and they do not grow on the tops of very high mountains, nor at very great depths in seas and lakes.

Plants grow in a great number of forms. Many of these forms, such as trees, shrubs, herbs, grasses, ferns, mosses, lichens, and seaweeds, are well known to us; but there are also many other kinds. The green and purple slimes that stain damp walls and rocks, and stones in water; the moulds which gather on food, books, and cloth; the smut, rust, and blight which spoil the stems, leaves, and fruit of ops; and even the dry rot which ats up trees, wooden houses, and ships, are plants which live, grow, increase, and die like the largest trees and shrubs.

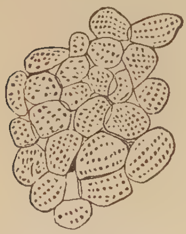
Some plants live but a short time, while others live for more than a thousand years. The most common forms may be divided into trees. shrubs, and herbs. Trees are woody plants with a single stem or trunk which rises to a great height. Shrubs are also woody plants, but they do not grow very high, never more than three or four times as high as a man, and usually much smaller, and when they do grow to such a height it is not by a single stem, but by several stems growing out of the ground. A woody plant not so high as a man is commonly called a bush, and slender woody plants which cannot hold themselves up are called vines. Herbs are plants with soft and brittle stems, which die down to the ground in winter, or die root and all each year.

Trees and shrubs are called perennials (Latin *per*, through, and *annus*, year), because they live on through many years. They are either evergreen or deciduous. Evergreen trees and shrubs keep their leaves all the year round; deciduous (Latin *de*, from, and *cadere*, to fall) trees and shrubs lose their leaves every winter.

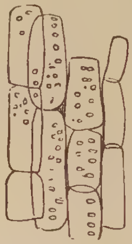
Herbs are divided into annuals, biennials, and perennials. Annuals (Latin *annus*, a year) grow up from the seed, blossom, and die in the same year. Indian corn, the grains, peas, beans, and many flowers are annuals. Biennials (Latin *bis*, twice, and *annus*, year) are herbs which live for two years. They do not blossom the first year, but live through the winter, flower the second year, and die when they have ripened their seeds. The cabbage, turnip, beet, parsnip, carrot, radish, and some flowers are biennials. Many herbs are like trees and shrubs, perennials, but most of them die down to the ground before winter.

Potatoes, sweet potatoes, dahlias, peonies, lilies, and flower-de-luces are perennials.

The substance of which plants are made up is called their tissue. There are several kinds of tissue, the difference between which can be



Round Plant Cells.

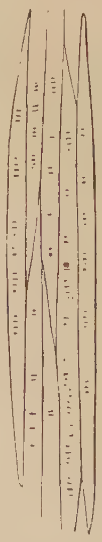


Long Plant Cells.

seen only with a MICROSCOPE. The principal substance of most plants is cellular tissue, which is a mass of many little bags or cells, some round or egg-shaped and some round and long like a barrel, crowded together so closely that there are as many as a hundred in an inch. The cells are divided from each other by partitions so thin that fluids can easily go through them, and the sap of plants is carried to the different parts chiefly by passing from cell to cell. On the outside of plants these cells are a good deal flattened, so as to form a kind of skin. All the fleshy fruits, such as the peach and apple, and root vegetables, like turnips, carrots, and beets, are made up of cellular tissue. In the pulp of an orange the cells can be seen put loosely together.

The woody parts of plants are made up of wood tissue, which consists of long thread-like pipes pointed at each end and filled with a matter which makes them tough. All kinds of wood are made up of these thready pipes, packed closely together side by side. In some plants they may be separated from the bark and stems by pounding or soaking in water; and in this way hemp and flax are got. Thready tubes twisted round like a corkscrew may also be seen in some plants, such as asparagus, the strawberry, and the geranium.

All parts of a plant—root, stem, leaves, flowers, and fruit—are made up of cells of different kinds, and by means of these the plant lives and grows. The cells of the root become filled with fluid, and this fluid, which in the plant we call sap, rises up through the cells of the stem, mostly through the woody parts when there are any, and passes into the cells of the leaves, where it is changed by the air and the light and made fit for its many uses. In trees and shrubs this changed sap passes down again through the inner bark, and in herbs through the soft parts it is thought, and all along meets and mixes with the sap going up, giving strength to the plant and causing it to grow. The two kinds of sap do not flow separately, but are all the while mixing together in all parts of the plant, and passing from one cell to another.



Wood Tissue.

When plants are growing, the younger cells divide and form new cells. In some plants, such as mushrooms and toadstools, new cells are thus formed very fast. The puff-ball will often grow in one night from the size of a marble to that of a child's head, merely by the dividing and growing of the cells in it. After cells have become too old to divide any more, they grow into the shape which they are to keep. Wood-cells grow much in length after they have stopped dividing, but the cells in cork and pith do not change much.

Plants need air, heat above freez-

ing, light, water, and some earthy matter to make them live and grow. A few kinds are exceptions, such as lichens, fungi, and mosses, which can stand much cold; fungi, too, grow well in the dark. The green of plants comes from a substance called chlorophyll (Greek *chloros*, green, and *phullon*, leaf), in the cells near the surface of the leaves and stems, which is not green itself, but is colored green by the action of light. Therefore, the parts of plants which grow underground, such as roots and bulbs, are not green; and mushrooms, which are usually raised underground, and celery, whose stalks are covered up with earth as they grow, are always white. But light does not change the colors of flowers. Hyacinths will grow in a dark cellar, and put out both leaves and flowers; the leaves will be pale, but the flowers will have their right colors.

Plants live on food which is partly gaseous and partly liquid. The gaseous food is CARBONIC ACID, which they get chiefly from the air, and take in principally by their leaves. The liquid food is water, which they take up mostly through their roots. The carbonic acid gas of the AIR goes into the cells of the leaves and is there acted upon by the sunlight, which divides it, the oxygen going back into the air and the carbon staying in the plant. The water taken up by the roots of plants becomes sap and passes up the stem and the branches until it reaches the cells of the leaves, where some of its oxygen and hydrogen unites with the carbon made by the sunlight from the carbonic acid, and forms starch. But a good deal of the water passes off into the air as vapor through thousands of little holes in the leaves, called pores. This passing off of vapor, evaporation as it is called, keeps plants cool in the hottest weather, and makes the air soft and pleasanter for us to breathe. In hot weather the air would be very dry and burning if plants did not breathe out moisture from their pores; and it is on account of the scarcity of plants that deserts are so dry and barren, and that the air of cities is dryer than that of the country.

In the water which plants take up from the earth are mixed SALTS, made up mostly of NITROGEN, PHOSPHORUS, SULPHUR, POTASH, and IRON. These substances are found in most soils where plants grow, and are a necessary part of their food. When the same kind of crop is raised year after year on the same ground, and is cut and carried away, all these substances are taken out of the soil, and it becomes poor and unfit to raise crops. Manure is, therefore, put on it to refresh it, because from its decay the soil gets back the substances taken away by the crops. When plants die and decay on the same ground where they grow, no manure is needed, for the substances which they took from the soil are thus given back to it.

The starch made in the leaves mixes in the sap with the salts taken from the earth by the water, and helps to make new wood, bark, leaves, flowers, and fruit, and a great many other things which make the differences between plants; such as sugar, found in the cells of sugar-cane, beet, and all sweet fruits; oils, found in seeds and fruits, such as flaxseed and cotton seed, and the olive, almond, cocoa-nut, etc.; resins, found in the pine, spruce, fir, and other trees; gums, such as India-rubber and gutta-percha trees; colorings, such as logwood and other dye-woods; medicines, such as quinine and rhubarb; perfumes, and a great number of other substances. Much of the starch of plants is laid up in those parts meant for the food of the plant during winter and for its growth in the spring. Thus, seeds, bulbs, and roots have a great deal of it and use it up as they grow.

Most plants grow from SEEDS,

Seeds look to us to be without life, being generally dry, and often very hard and even bony; but they have life in them, and will grow if they are put where there is dampness and heat. Seeds kept dry will not change at all, and some kinds will keep life in them for a great many years; but the stories told about seeds taken from Egyptian mummies several thousand years old, which grew when planted, are not trustworthy, although seeds which have been buried in the earth for many years have been known to sprout and come up.

In the article SEEDS is told that all seeds may be divided into two classes, those with one seed-leaf or cotyledon, and those with two seed-leaves or cotyledons; and that plants which grow from the first kind of seeds are called monocotyledons (more fully, monocotyledonous plants), and those which grow from the second kind, dicotyledons (more fully, dicotyledonous plants). Most of the plants in cool climates are dicotyledons; thus all of our forest and fruit trees and most of our shrubs and flowers belong to this class, but the palmetto tree, Indian corn, and other grain-plants, the onion, lilies, and like plants, are monocotyledons. Many trees of hot climates, such as the palms, are also monocotyledons.

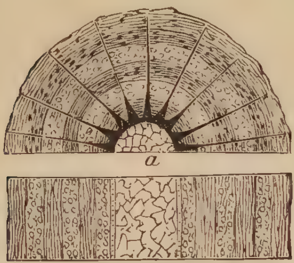
When seeds are planted the dampness in the earth makes them swell. The skin of the seed soon breaks, and a little root pushes out and goes downward into the ground, and then a stalk comes out and shoots upward. We do not know what makes the root go down and the stalk go up, but they always do so, no matter how the seed lies in the ground. The coverings of some seeds, such as peach stones, walnuts, and other nuts, are very hard, but when they soak in the ground they swell and crack open, and let out the roots and the stalk just as beans and corn do.

Some roots taper or grow down to a point, as in the carrot and the radish, and are called tap roots; others are like a bunch of threads hanging down, like most grass roots, and are called fibrous roots. In shrubs and trees the tap roots have branches which, like the tap roots, grows thick and woody. Both are covered with fine roots called root hairs, and it is these which suck up water from the soil. Roots generally go down into the soil at once; but some roots come from different parts of the stem and grow in the air first. In the banyan tree of India, roots sprout from all parts of the branches and run down to the earth, thus forming many stem-like roots which help to hold up the limbs of this wide-spreading tree. There are two kinds of roots, those which simply feed the plant as it grows, and those which lay up food to help the growth of the plant the next year. Among the first kind are the roots of trees, shrubs, and grasses; among the second kind are such roots as those of the beet, carrot, turnip, radish, and dahlia.

The use of the stem is to hold up the leaves, buds, and flowers, and to carry the sap to the different parts of the plant. The stem usually grows up into the light, but not always; some stems grow underground, and are often mistaken for roots. Thus the bulbs of onions, leeks, tulips, and lilies are really stems, as are also the woody underground runners of some kinds of grass. These underground runners are called root-stocks, because roots spring from them. The potato is only a fleshy root-stock, and not really a root. Of the stems which grow out of the ground, some have short and some tall stems, some are with branches and some without branches, and some are straight and some twined. Of twining stems, like the hop, ivy, honeysuckle, and grapevine, some turn toward the right and some toward the left, but the same kind

of plant always twines the same way.

Plants have two principal kinds of stems, one belonging to dicotyledonous plants and the other to monocotyledonous plants. The differences can easily be seen by comparing the branch of a tree with a cornstalk.

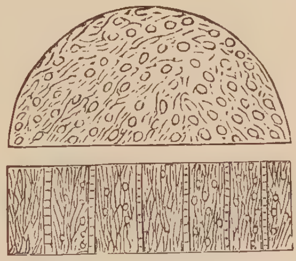


Exogen, Top and Side View.

The fourth picture shows in its upper part half of a branch of a tree cut across, and in its lower part the same split downward; and the fifth picture shows half of a cornstalk cut and split in the same way. The tree has a bark on the outside which easily comes off from the wood, and the inner part is solid wood, but the cornstalk has only a thin skin, which will not peel off clean like bark, and the inner part is not hard, but soft and stringy. In the branch the part inside the bark is made up of two kinds of wood, heart-wood and sap-wood. The heart-wood, marked *a*, is really a pith, because it is made up of cellular tissue and has no wood in it; but it is not soft like common pith. It is the oldest part of the plant, and never grows any after the first year, because its cells or pipes are stopped up so that no sap can flow through them. The tree lives and grows only in its sap-wood, which is the part between the heart-wood and the bark. The sap-wood grows in rings around the heart-wood, as shown in the picture, one ring growing each year, so that by counting these rings in trees which have been cut down we can tell how many years old a tree is. The new ring always grows on the outside of the other rings, next to the bark. and plants which grow in this way are therefore called exogens (more fully, exogenous plants), or outside-growing plants. The growth is always in warm weather, as the tree sleeps in winter.

In the cornstalk the growth is different. The stem is at first entirely made up of cellular tissue, but in time bundles of woody threads are formed which grow and push out the stem; as the leaves grow, new threads grow and push down inside the older ones, shoving them toward the outside, and so on until the stem is of full size. Thus the growth is on the inside, instead of on the outside, as in the exogen, and this kind of plant is therefore called an endogen (more fully, an endogenous plant) or inside-grower.

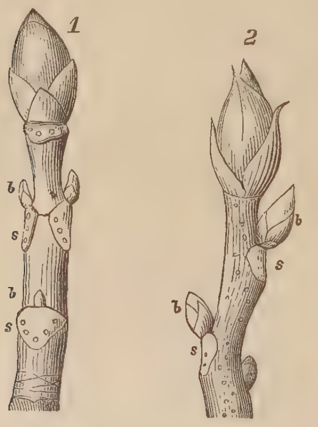
Plants with outside-growing stems, especially those which live from year to year, usually have many branches; but those with inside-growing stems seldom branch.



Endogen, Top and Side View.

Branches grow from buds. The plumule, or first shoot of the embryo of the SEED, is a bud which makes the main stem of the plant. Palm trees have no other bud, and therefore branch only at the top; but dicotyledonous plants have many side branches, and therefore have

many more buds. These side buds grow out from the axils of leaves. The axil (Latin *axilla*, an armpit) of a leaf is the hollow part of the leaf stalk, on the upper side, where it joins the stem. Now, as leaves grow on stems generally in two ways, either in pairs opposite each other, or singly one after the other, so the buds of branches grow in the same way. In the picture, 1 is a last year's shoot of a horse-chestnut tree, from which the leaves have fallen; but the leaf-scars, *s*, or places where they grew, are shown opposite each other, and the buds, *b*, are seen sprouting out above them. In 2, which is a last year's shoot of hickory, the leaf-scars, *s*, are not opposite but one above another, and the buds, *b*, grow in the same way. If all the buds grew, the branches of



1. Horse-Chestnut Shoot. 2. Hickory Shoot.

plants would be very regular, but as there is not room for all, only the stronger ones grow, and so the branches look irregular.

The leaves of plants are generally flat and thin, with one side turned toward the sky and the other toward the earth. If put in a room the leaves will turn toward the light —so much so that to have pretty, round plants one must turn the plant around daily. Leaves are made up of the same two kinds of things as stems—woody fibres or threads, and cellular tissue. The woody part makes the framework of ribs and veins, and the cellular tissue the green pulp which is spread all over and is held in place by the framework. Over the whole is a thin clear skin. The larger parts of the framework are called ribs, the one down the middle being the midrib and the smaller parts veins. If you look carefully at several different kind of leaves you will see that they are veined in different ways: in some the veins run in every way, making a kind of net-work, as shown in the picture of a netted-veined leaf, while in the others the ribs and veins run parallel or side by side from the base to the top of the leaf, or from the midrib to the sides of the leaf. Thus we have two classes of leaves, netted-veined and parallel-veined. Netted-veined leaves belong to dicotyledonous plants, whose stems are exogens or outside-growers; and parallel-veined leaves to monocotyledonous plants, whose stems are endogens, or inside-growers.

Netted-veined Leaf.

We have thus far shown only how plants grow from seeds; but a great number of plants grow also from buds. Gardeners make plants grow from buds when they plant slips in the ground, or set GRAFTS and buds into the stems of trees. Plants grow naturally from buds when they send up suckers from their roots, as most trees do, and form new plants by means of runners, like the strawberry and many kinds of grass. Sometimes, too, a branch bends down to the ground and takes root as shown in the picture on page 581. Such

a branch is called a stolon. Currant bushes usually spread in this way. Branches thus bent down by gardeners to make them take root are called layers. The tubers of potatoes and of ground artichokes are filled with buds, or eyes as they are commonly called, from which a new crop is raised every year. Potatoes have seed, but they are seldom raised from them. Plants with bulbs, such as tulips, also form little bulbs from buds in their scales from which new plants grow.

Parallel-veined Leaves.

All plants do not bear true FLOWERS and real seeds (see FRUIT), although all have something which answers to seeds; and we can therefore divide them into two series or sub-kingdoms, flowering plants and flowerless plants. Flowering plants include almost all trees, shrubs, and herbs. FERNS, MOSSES, SEA-WEEDS, LICHENS, and FUNGI are all flowerless plants. They have no real seeds, but have small and simple bodies called spores which answer for seeds. As flowerless plants are very hard to understand, only flowering plants have been told about in this article.

Thus the vegetable kingdom is divided into two sub-kingdoms, flowering plants and flowerless plants. Flowering plants are again divided into two classes, which differ from each other in stems, leaves, and seeds. These are:

1. Dicotyledonous plants, exogens, or outside-growers, whose stems are made up of a central pith, of layers of wood around it, and of a bark outside; whose leaves are net-veined; and whose embryo in the seed has two cotyledons or seed-leaves.

Stolon. Sucker. Runner.

Growth of Plants from Buds.

2. Monocotyledonous plants, endogens, or inside-growers, whose stems are made up of woody threads mixed with pith, and whose bark will not peel off clean; whose leaves are almost always parallel-veined; and whose embryo in the seed has but one cotyledon or seed leaf.

There are also differences between the flowers of these two classes, which the student will learn when he studies botany. These classes therefore may be easily told apart by looking at their stems, leaves, flowers, or seeds; and by examining any seed we can tell what kind of a plant will grow from it.

The classes are further divided into orders or families, each one of

which is named after some chief plant of its order, as the oak family, the pine family, the rose family, the poppy family, etc.

Flowerless plants are divided into three classes: 1, FERNS; 2, MOSSES; 3, LICHENS, SEAWEEDS, and FUNGI.

Plants have a great many uses. They keep the air pure by taking up the carbonic acid which is breathed out by animals, keeping the carbon and giving back the oxygen to be used by animals over again. The carbon which they thus get is changed into vegetable matter, on which all animals live, some by eating it, and some by eating animals which have fed upon it. Thus the substance of all animals is made up from plants. They give us, too, not only food, but many comforts and luxuries, and even medicines. All our clothing comes from plants, not only what is made directly from them, as cotton and linen, but also silk, which the silkworm spins from leaves, and wool, which is made like flesh from the food of the animal which bears it. Plants give us material out of which we build our houses, fences, and other buildings, and from which we make our furniture, tools, and a great number of other things; and they furnish our fuel, both wood and coal, and supply us with light, whether gas, oil, or candles.

The word plant is from the Latin *planta*, a sprout or shoot.

PLATINUM, a METAL and one of the ELEMENTS. It is commonly found, like GOLD, in grains, scales, or nuggets, and is got by washing away the earth and sand with which it is mixed. When pure, it is whitish gray (not quite so white as silver), heavier than gold, as soft as copper, and may be hammered into thin plates and drawn out into fine wire. It cannot be melted in any common heat, but only in a blowpipe flame. As it does not rust in the air at any heat and is not eaten by any of the common acids taken alone, platinum is a very useful metal. The chemist uses it for CRUCIBLES, BLOW-PIPE tips, and many other things, and large stills (see ALCOHOL) made of it are used in making SULPHURIC ACID. It is much used also for electrical and mechanical apparatus. Platinum forms ALLOYS with gold, silver, and most other metals. Most of the platinum used in the arts comes from the district of Perm in the Ural Mountains, Russia, though some is brought from South America, California, Australia, Ceylon, and Borneo. It is about five times as valuable as silver.

Platinum was first mentioned by Don Antonio Ulloa, who went in 1736 to Peru with the members of the French Academy of Sciences, who were sent there to measure a degree of the meridian so as to prove the shape of the earth.

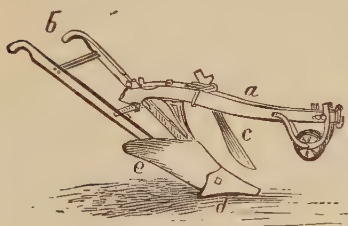
The word platinum is in Spanish *platina*, little silver, which is from *plata*, silver, and the metal gets its name from its color.

PLOUGH, an implement for breaking up or loosening the soil. Ploughs were in use in very ancient times,

Ancient Greek Plough.

but they were mostly very rude instruments, often little more than sharpened crooked stakes, with a beam to draw them by. The Greeks, however, made better ploughs, and some used by them more than two thousand years ago were much like the best ploughs of the present day. It will be seen from the picture of an ancient Greek plough, used about two hundred years B. C., that the root-cutter and the wheel at the end of the beam are not new things, as many think.

The modern plough is made up of the beam (*a*), which is usually of wood, but sometimes of iron, and which has a wheel near its end to run along on the surface of the ground, and thus to keep the share from going too deep into the earth; the handles or stilts (*b*), also generally of wood, but sometimes of iron; the steel knife or coulter (*c*), which cuts through grass and roots in front of the share; the share (*d*), of steel or hardened iron, which cuts the



Modern Two-Horse Plough.

earth at the bottom of the furrow; the mould-board (*e*), also of steel or hardened iron, which turns over the earth cut by the share; and the land-side, not shown in the picture, or straight iron part, back of the mould-board, on which the plough stands. Side-hill ploughs are so made that the mould-board can be changed from one side to the other of the beam, so that the plough can come back and turn a furrow against the one last made. Subsoil ploughs have no mould-board nor share, but are made with a long flat point to stir up the soil in the furrow made by the common plough. Steam ploughs are now used to some extent in England and on very large farms in this country. These have usually three or four shares and mould-boards, so as to turn as many furrows at once, and are drawn by a steam-engine which looks somewhat like a locomotive. The engine may be used also to draw wagons on common roads, and to drive pumps, saws, threshing machines, and other machines.

The word plough is found in different forms in many languages. In German it is *pflug*, in Danish *plov*, in Swedish *plog*, and in Russian and Polish *plug*.

PLOVER. There are several kinds of plovers in the United States. The golden plover is brownish black on the back with golden spots, and black or gray and black on the breast. It lives in small flock on the sea-coast, makes its nest of dried grass in a hollow in the sand, and lays four eggs. The upland or field plover is brownish black on the back and yellowish white on the breast. It is found mostly in cultivated fields, and lives on seeds, berries, and insects. It gives excellent sport in the autumn, when it is fat and very good eating. Other common kinds are the ring plover, which has a white ring round its neck; the killdee, so called from its shrill notes which sound like kill-dee or kill-deer; and the piping plover, whose notes are sweet and sad.

The plover belongs to the order *grallatores*, or wading BIRDS.

The word plover is in French *pluvier*, the rain-bird, from the Latin *pluvia*, rain; and this bird is so called because it appears during the rainy season.

PLUM, the FRUIT of a tree of the same kind as the almond, peach, apricot, and cherry. The plum grew first probably in Western Asia, but it spread early into Europe. Pliny says the Romans had a great abundance of plums, but none have been found pictured at Pompeii. The plum tree grows wild both in the United States and in Europe. Of those in the United States the Chickasaw is one of the best. Other common ones are the yellow or red plum, which grows wild all over the country, and the beach plum, a small purple kind, which grows in the sands of the sea-shore all along the Atlantic coast. The beach plum is somewhat bit-

ter, but makes good preserves. The best of the cultivated plums is the green gage. The damson, a small black plum, gets its name from Damascus, from which place it is supposed to have come. Plums are eaten for dessert, and are made into preserves and PRUNES. A kind of wine is made from them in Europe, and a strong liquor is distilled (see ALCOHOL) from a mixture of plums, honey, and flour.

The word plum is from the Anglo-Saxon *plume*, plum.

POLECAT, a small animal much like the weasel in shape, found in Europe and Asia. It is dark brown above and yellowish brown below, and has black legs and tail. It lies hidden all day long and comes out at night to rob hen-roosts and pigeon houses; it also kills rabbits, squirrels, and other small quadrupeds. When frightened or angry it gives out a very bad smell, which is disliked by all other animals. The polecat is killed for its fur, which is commonly called fitch, and the animal itself is sometimes called fitchew or fitchet.

The word polecat means chicken-cat, being made up of the French *poule*, hen or chicken, and cat.

POMADE, or **POMATUM**, a perfumed grease for dressing the hair. It is made of some fine fat, such as lard or suet, which has been purified, thickened with a little wax or spermaceti and perfumed with some essence. Many different kinds are made by the perfumers.

The word pomade is from the French *pommade*, which is from the Latin *pomum*, apple, because it was formerly made by boiling apples in fat, by which the scent of the fruit is given to the fat.

POMEGRANATE, the FRUIT of a shrub or small tree which grows wild in Southern Asia, especially in Persia and Afghanistan. It was early carried west and then into China, and is now cultivated in many warm countries. Very fine pomegranates are raised in the Southern United States, Mexico, and South America. The tree grows sometimes three or four times as high as a man; but is usually smaller. The fruit is about

Pomegranate.

the size of a large orange, and has a thick leathery skin of a deep orange color tinged with red. The pulp and the seeds with which it is filled are the parts eaten. It is of a sweet, delicate flavor, sometimes a little acid. Cooling drinks are made of it in hot climates, and in Mexico and South America it is distilled (see ALCOHOL) to make a kind of spirit called *aguardiente*.

The rind of the fruit and the bark of the root contain much TANNIN, and are used for tanning the finest morocco leather. The bark of the root is used also as a medicine, especially for worms.

The word pomegranate means many-seeded fruit, it being from the Latin *pomum*, apple or fruit, and *granatum*, many-seeded. The Romans called it also *malum Punicum*, Carthaginian apple, because the best pomegranates came from Carthage, where the shrub had been early carried by the Phœnicians.

POMPANO, a fish common in the West Indies and in the South Atlantic and Gulf States. It grows about 18 inches long, has a blunt nose, and is bluish above and silvery or golden on the sides. It is much esteemed for food.

The **California Pompano**, abundant on the Pacific coast in summer, is a different kind of fish. It is seldom more than a foot long, and is

blue above and silvery below. It also is a good food fish.

The word pompano is from the Spanish *pampano*.

POPLAR, a tree of the same family with the willow, which grows chiefly in mild and cold climates. Of the several kinds of poplars in the United States the cottonwood is the most abundant, being found from New England to the Pacific coast. It gets its name from the downy cotton with which its seeds are covered. Its flowers look somewhat like a string of pearls, from which it is sometimes called the necklace poplar. Its wood is not very good, but it is much used in the West where other large timber is not easy to get.

The **Balsam Poplar** or tacamahac and the balm of Gilead are also American varieties of the poplar. Their buds are covered in the spring with a sticky varnish called balsam.

The **White Poplar,** or abele, so called because its leaves are white underneath, was brought here from Europe. Its wood is used by cabinet-makers, turners, and toy-makers.

The **Lombardy Poplar,** so called because it first became well known in Lombardy, although it came from the East, was once much planted in this country, especially in avenues, but is now seldom seen. It is an unsightly tree, and its wood is worthless.

The word poplar is from the Latin *populus*, the poplar tree.

PORCELAIN. See POTTERY.

PORCUPINE. There are several kinds of porcupines, all of which are covered with sharp quills, which they can make bristle or stand up, so as to protect them from their enemies. These quills commonly lie close down on the body, but when the animal becomes angry or afraid they all spring up and stand stiff as a forest of bayonets. If the animal is attacked, it turns its back toward its enemy, put its head between its forepaws, makes a grunting noise, and tries to push its quills against the body of its foe. The wounds made by its quills are very bad and hard to cure, as the ends often stay in the flesh.

The **Canada Porcupine** is the most remarkable of those living in America. It weighs commonly about twenty-five pounds and is two and a half feet long, to the beginning of its tail, which is eight or ten inches more, but looks larger than it is on account of its long hair and bristles. Its fur is dark brown, sometimes mixed with gray. The quills, which are two or three inches long, are mostly hidden by the fur so that they are not seen until they stand up. This porcupine lives in the woods, where it feeds on the bark of trees, especially that of the elm and hemlock. When it climbs up into a tree, it seldom leaves it until the bark is all eaten, excepting in very cold weather, when it comes down at night to sleep in some hollow place. As the tree is thus killed, it does much damage to woods. The Indians hunt it for its flesh, which they eat; for its skin, which they make into caps and other things; and its quills, which they dye of beautiful colors and use for ornaments. In New England the Canada porcupine is wrongly called the hedgehog.

The **Crested Porcupine** is found in southern Europe, in Asia, and in Africa, but not in this country. It is so called because its quills stand up all over it like a crest, some of them being more than a foot long. It is larger than the Canada porcupine, and is brownish black, with white round the neck. It lives in holes between rocks, or in burrows that it digs in the earth, and in which it lies numb in the winter. Its food is mostly herbs and fruits which it comes out at night to eat.

The porcupine is a MAMMAL of the order *rodentia*, or gnawing animals.

The word porcupine is from the Latin *porcus*, pig, and *spina*, thorn. The French call this animal *porc-*

epic, spiny pig, and the Danes call it *pinsvin*, pin-hog.

PORGY. See SCUP.

PORPOISE. This animal is usually five to six feet long, bluish black on the back, and white beneath; is shaped like a fish and lives all the time in the water, but breathes air and has to come to the top of the water to blow, like the whale. It is common along the Atlantic coast, and may often be seen in bays and near the mouths of large rivers, playing and tumbling about in the waves. When swimming its round back looks like a hog in the water. Porpoises live mostly on fish and MOLLUSKS, and they will root like hogs in the sand in search of clams, sand EELS, and other food. Sometimes they hunt after sand eels in companies and drive them up into a mass just as hunters drive game in some countries. For this purpose they form a circle about a shoal of these eels, and by swimming round and round, now on top of the water and now diving down, they soon force the frightened fish into a thick crowd on the top of the water into which they can dash and seize a dozen or two at a mouthful. Porpoises sometimes swim in groups one after the other, and so closely that they look like one long animal, and some think that they thus gave rise to the stories of the sea-serpent. Sailors eat the flesh of porpoises, which looks somewhat like pork. A fine oil is made from their blubber or flesh, and good leather for the uppers of boots and shoes from their skins.

The porpoise is a MAMMAL of the order *cetacea*, and of the same family with the DOLPHIN.

The word porpoise is from the Old English *porcpisce*, which is made from the Latin *porcus*, hog, and *piscis*, fish. The Italians call it *porco marino*, sea-hog.

POTASH (POTASSIUM oxide), an ALKALI, much used in the arts. The potash of trade, usually called crude potash, is very impure, and is properly potassium carbonate, because it contains CARBON as well as potassium and OXYGEN. It is commonly made out of wood ashes and the ashes of various plants. Once almost every farmer had near his house a tub called a leach-tub, filled with wood ashes which were kept wet with water. The water drizzled down through the ASHES, soaked up all the potash in them, and dripped out of a little hole in the bottom of the tub, in the form of a strong yellow liquid called lye. This lye was afterward boiled in iron pots until the water in it passed off as steam, leaving the solid potash on the bottom. The potash of trade is made in the same way, and great quantites of wood are burned in the forests in this country, Canada, Russia, and Germany, solely to get ashes for making it.

Crude potash is largely used in the manufacture of glass, porcelain, earthenware, and soap. It is reddish brown, but can be purified by heating in a furnace, and then becomes pearly white, and is called pearlash. Saleratus is rightly potassium carbonate with more carbon added to it, so that it is potassium bicarbonate; but SODIUM bicarbonate is now mostly used instead of it. Caustic potash, much used in chemistry and in medicine, is made from crude potash, or potassium carbonate, by dissolving it in boiling water and mixing lime with it. The lime seizes the carbon, unites with it to form CALCIUM carbonate, and the rest of the liquid may then be drawn off and boiled until the water passes off as steam. When it becomes thick, it is poured into moulds and left to harden. It is thus made into the little round sticks used by physicians as caustic. It is properly potassium hydrate, as it is made up of potassium, HYDROGEN, and oxygen. The chlorate of potash (potassium chlorate) is made up of potassium, CHLORINE, and oxygen.

It is much used in medicine, especially in cases of scurvy and rheumatism; in calico printing, and in making MATCHES and FIREWORKS.

Potash is so called because it was formerly made by boiling down wood ashes in pots.

POTASSIUM, a METAL and one of the principal ELEMENTS. When pure it is silvery white, very bright, lighter than water, and at common heat soft as wax. It is never found by itself, as it has such a liking for OXYGEN that it will unite with it if left where it is, and form potassium oxide, an ALKALI, commonly called potash. Therefore it can never be left where the air can get at it nor be kept in water, but has to be kept in PETROLEUM, which has no oxygen in it. If a small piece be thrown on to water it will at once fly around on the surface and unite with the oxygen with so much heat that the hydrogen which is set free will catch fire and burn with a beautiful violet flame. The metal potassium is made by chemists by taking away the oxygen from potash. The salts of potassium are very useful in the arts. The most important of them are POTASH (potassium carbonate), made up of potassium and CARBONIC ACID; nitre or SALTPETRE (potassium nitrate), made up of potassium and NITRIC ACID; and chlorate of POTASH (potassium chlorate), made up of potassium, CHLORINE, and oxygen. What is commonly called "cream of tartar" is made up of HYDROGEN, potassium, CARBON, and oxygen (hydrogen potassium tartrate).

Potassium gets its name from POTASH.

POTATO, the tuber or root of a plant of the same family with tobacco, the tomato, egg plant, and many other plants. Next after the cereals or grains the potato is the most valuable of all plants used for human food; and, like maize or Indian corn, it was first given to the world by America. It is often called Irish potato, but is was not known in Ireland until it was carried there from Virginia about three hundred years ago.

The native country of the potato is Chili, where it grows wild in abundance, but it is doubtful whether it ever grew wild in Peru and Colombia, as some writers say, though it was cultivated in those countries before the discovery of America. There is no mention in history of its cultivation in Mexico before the time of the Spaniards, and it was not known among the North American Indians previous to the arrival of white men. It was introduced into what is now Virginia and North Carolina probably in the latter half of the sixteenth century. The Spaniards first carried it to Europe between 1580 and 1585, and Sir Walter Raleigh took it from Virginia to Ireland in 1585 or 1586.

The potato is now largely cultivated in most mild climates, and to some extent in warm and cold climates. There are a great number of kinds, which differ much in size, form, color, the time of ripening, and in the quantity which can be raised to the acre. New kinds are raised from the seed, but potatoes are usually grown by planting the tubers or cuttings of them, care being taken to have an eye in each piece. The tubers are not properly roots, but are underground parts of the stem of the PLANT, and are stores of food for the support of the new plants which are to spring from them. The earliest potatoes which are brought to our markets come from the Bermuda Islands, where great quantities of them are raised every winter. As the climate of Bermuda is too hot to keep potatoes through the summer, the seed has to be sent there from the United States every autumn.

About three-fourths of the weight of a full-grown potato is water, and of the other fourth about one-sixth is GLUTEN and five-sixths STARCH.

The potato contains also a little of a poisonous substance called *solanine*, having a bad taste and smell, but which is taken out in boiling, as it is chiefly in the skin. It is this which gives the bad smell to the water in which potatoes have been cooked, and as it is unwholesome this water ought always to be thrown away. Potatoes should always be stored in a dark place, as the light is apt to make them green and bitter, as is often seen in those which in growing have come partly out of the ground. There is much solanine in such potatoes, and they are unfit to eat.

Potatoes are used for food for domestic animals as well as for man. They are also largely made into starch, and in some countries this starch is turned into glucose or grape SUGAR. In Ireland whiskey is distilled (see ALCOHOL) from potatoes, and in northern Europe potato brandy is made from them.

The word potato is from the Spanish *patata* or *batata*, Haytian *batata*, a name which belongs rightly only to the SWEET POTATO.

POTTERY, anything made out of baked clay. When a child makes a dish out of soft clay and dries it in the sun, he becomes a potter. The first earthenware was probably made in this way; but it was soon found out that it could be made much harder by baking it in the fire. Fire drives out the water and melts the sand in the clay, and thus makes it firmer and less easy to break. By and by potters learned how to mix other things with clay so as to make finer and more delicate pottery, to give it graceful forms, and to paint and decorate it, and in time the art of the potter became one of the most important known to man.

Pottery may be divided into three kinds: earthenware, stoneware, and porcelain or china.

Earthenware is soft and porous, that is, so full of little pores or holes that water will soak into it. A common brick or a flower pot is the simplest kind of earthenware. The finer kinds of earthenware, of which all table ware that is not porcelain is made, is covered with a kind of glass varnish called a glaze, which fills up its pores and gives a smooth glassy finish to its surface. If it were not for this our earthenware tea-cups and coffee-cups would leak. The finest earthenware is often painted and beautifully decorated. Such earthenware is generally called faïence or majolica. Faïence is a name taken from Faenza, a city in Italy, where much decorated earthenware was once made; and majolica, or maiolica as it is sometimes called, is supposed to come from Majorca, an island in the Mediterranean, where the Arabs formerly made a great deal of fine pottery. Delft ware is a kind of faïence or earthenware made at Delft in Holland. Terra cotta is a soft, porous kind of earthenware, much made into ornaments. It is sometimes, but not usually, glazed. Many busts and little statues are made of it.

Stoneware is a very hard, dense, close-grained kind of pottery, and is either white or colored, glazed or unglazed. Common stone jars, such as preserve and pickle jars, are the cheapest kind of stoneware. Some stoneware is fine and can scarcely be told from earthenware. The chief difference is that in stoneware the clay is so melted together that it is not porous.

Porcelain is the finest kind of pottery. It is very dense, hard, and fine-grained, and is white and translucent, that is, the light will shine through it. All the fine table ware usually called china (because the first was brought from China) and the beautiful vases made at Sèvres and Dresden are of porcelain. The word porcelain comes from the Portuguese word *porzellana*, which was first given to a kind of majolica, but we do not know its exact meaning. Some say it was named from the *porzellana* or *porcellana* shell,

because its surface looks like the enamel of that shell; and others that the first cups brought from China were shaped somewhat like this shell, which was called *porcellana*, from *porcella*, a little pig, because it looks somewhat like a pig's back.

Pottery Manufacture. All kinds of pottery are made out of clay, but the clay is mixed with many different things, such as sand, flint (burnt and ground), feldspar, chalk, alum, soda, and bone ash. In making the common kinds of pottery the clay and other things are simply ground up in a mill with water into a kind of putty called "paste," but the finer kinds need greater care in choosing and mixing the materials. Sometimes the materials are mixed together dry and then made with water into a thin cream called "slip," which is afterward strained until it becomes a paste of the right thickness for moulding.

After the paste has been made, it is formed into the various vessels on the potter's wheel or lathe, which is shown in Fig. 1. It is simply an upright shaft, *a*, with a small stone wheel on top, *b*, which is made to turn round by a large wheel, *c*, turned by a boy, or by a treadle moved by the workman's foot. In some potteries the lathe is turned by steam power. The potter's wheel

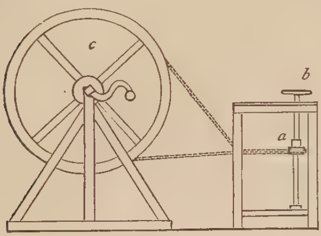


Fig. 1.—Potter's Wheel.

is sometimes called the throwing wheel, and the making of any vessel on it is called throwing, because the potter throws the soft clay down on his wheel to make it stick fast. If he wishes to make a stone jar, he first shapes it into a kind of cone, shown in *a* (Fig. 2), by pressing it with his hands, which he keeps wet. This softens it and works the air out

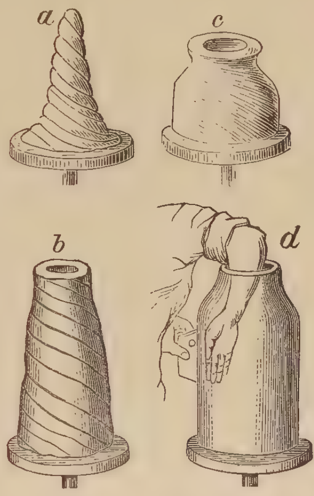


Fig. 2.—Making a Jar.

of it. He then puts his thumbs into the middle of it, keeping his fingers on the outside, and makes it into the form shown in *b*. Afterward, with one hand inside and the other outside, and the use of a sharp tool kept wet, he gives it the forms *c* and *d*. When it is done, the potter cuts it from the wheel with a fine wire, and it is set upon a shelf to dry until the time comes to bake it.

Some articles are made in plaster of Paris moulds instead of being thrown on the wheel. Ewers or pitchers are mostly made in this way. The mould is in two parts, each part making one half of a pitcher cut through the spout and handle from top to bottom. Each half is lined with a sheet of the paste, and the two parts are then put together and joined by putting the hand inside and pressing the seams together with the fingers. Some-

times pitcher moulds are made whole, with an inside and an outside part, and the paste, made very thin, is poured in so as to fill all the space between. The plaster of Paris mould takes up the water and the paste soon becomes dry enough to be taken out. The potter usually has about a dozen moulds near him, so that by the time they are all filled, the first one will be ready to empty. Tea-cups and other round cups are made in a mould which forms the outside. The mould is then put upon the wheel and turned, the inside of the cup being shaped with the fingers and finished with a wet sponge. They are thus all made of the same size and shape. Handles are always made and put on after the pitchers or cups are moulded, being fastened on with a little wet paste, and the parts where they are joined smoothed with a wet sponge. Saucers and plates are made by pressing a thin sheet of paste on to a plaster of Paris mould, shaped like the inside. The whole is put on the wheel and the outside is shaped by a glass form or thin plate (Fig. 3) made to fit one half the bottom. As the wheel turns round the form presses on the mould and shapes the

Fig. 3.—Making a Plate.

outside of the plate, paring off all the paste which is not needed, and making each piece of the same thickness.

Baking. When finished the pieces are dried in a drying room, and then carefully packed in coarse earthenware vessels called seggars (Fig. 4), which are so made that they can be piled up, one above another to a great height in the kiln. When several plates or other articles are put into one seggar, little pointed pieces of earthenware are placed between them, so that they cannot touch each other, as they would be apt to stick

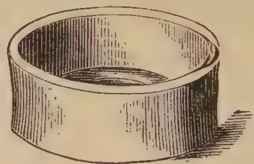


Fig. 4.—Seggar.

together when baked. Each seggar thus forms a small oven, in which one or more pieces are baked, and in which they are kept from being smoked and from being unevenly heated. The baking, which usually takes a day and a half, has to be done with great care. When finished the fire is put out, and the whole is allowed to cool little by little, after which the seggars are taken out and unpacked.

Glazing. The pottery, which at this stage is called "biscuit" ware, is without any gloss, and so porous that water will soak into it. The next thing is to glaze it, so as to give it a smooth shiny surface and to make it water-proof. The glaze for earthenware is usually made of white clay, ground QUARTZ, FELDSPAR, white LEAD, and some other things. All are ground fine and mixed with water enough to make a milk-like liquid. Each piece is carefully dipped into the glaze so as to cover it all over equally, and then set upon a bench. The water of the glaze soaks into the biscuit, leaving a thin film on the outside. The articles are again put into seggars, and baked in a glaze-kiln for about half a day, when they are cooled again slowly. The glaze is melted by this baking and spread evenly all over the surface. Paintings or other decorations on earthenware are put on the biscuit before the glazing. Designs

for common earthenware are often printed in enamel colors on paper, and pressed on the biscuit while the ink is still wet. The biscuit takes up the ink, the paper is taken off, and the articles are then glazed and baked. The figures and colors are thus under the glaze, and cannot be injured.

Porcelain Manufacture. Porcelain is made in much the same way as earthenware, but the materials are finer. The paste is made of a fine white CLAY called kaolin mixed with several other things, and much care has to be taken in throwing and moulding it. Some of the pieces are very thin, and only the best workmen can make them. Porcelain is baked first with much less heat than earthenware. When cool it is dipped into a different kind of a glaze from that used on earthenware, and is then baked so hot that it melts and forms all over the article a glassy surface so thin and clear that light will shine through it. The glaze must be very carefully made, because if it melts too easily it will sink too much into the biscuit, and if it does not melt easily enough it will not make a smooth surface. The pictures on painted porcelain are sometimes put on the biscuit before it is glazed, and sometimes on the outside of the glaze. The paints are made of different colored glass ground up fine and mixed with oil of TURPENTINE, and are put on with brushes. The porcelain is then heated in a kind of box called a "muffle" until the colored glasses are melted just enough to stick fast to the surface.

Painting porcelain is very pretty work, and is now much done by ladies who have the taste and time for it. Plain ware ready to be decorated is made by many of the manufacturers, and the right paints, put up in tin tubes like the oil paints used by artists, and the other things needed, are sold at most of the crockery stores.

Very good table ware porcelain is made in the United States, but the finer kinds come from France, Germany, and England. The most costly painted vases and other ornaments are made at Sèvres in France, and at Dresden in Germany; but very beautiful ones are made also in Vienna and Berlin, and in several places in England. Splendid decorated vases, jars, and other ornamental porcelain are brought also from China and Japan, where they have been made for many hundred years. The painting of porcelain and cloisonné work are told about under ENAMEL.

History of Pottery. The people of ancient Nineveh knew how to bake and to glaze pottery, and both glazed bricks and tiles have been found in the ruins of that city. On the monuments of Thebes are to be seen pictures of potters at work, which show that earthenware was made many centuries before Christ in nearly the same way as it is now. The Phœnicians made fine pottery, and many beautiful vases, jars, lamps, cups, and other utensils of their manufacture were brought from Cyprus by General di Cesnola, and are now to be seen in the Metropolitan Museum in New York. The Greeks probably learned the art of making pottery from the Phœnicians and Egyptians, and the Romans learned it from the Greeks. The Greeks were noted for the beauty of the form and the ornaments of their pottery, and many of the finest vases now made are imitated from those made by them. The Arabs learned from them and in time carried the art into Spain, where much beautiful pottery was made at an early date, especially in the island of Majorca, where majolica ware was made. In the fifteenth century, the Italians began to make majolica and other wares, and soon Faenza, Florence, and other cities had famous factories. All their ways of working were kept secret, but about the middle of the

sixteenth century, Bernard Palissy, a French potter, found out the way of making majolica, and also made many improvements in the art. He had seen some fine pieces of Italian work, and made up his mind that he would find out the secret. His experiments cost him a great deal of money, and he became so poor that he and his family were nearly starving; but after sixteen years of hard work, he at last succeeded, and made better ware than the Italians themselves. Most of his pottery is ornamented with pictures of sea animals and plants, and his fish, crabs, shells, coral, and seaweed look almost as natural as life. Many of his works are still to be seen in museums, and are highly valued.

About the same time pottery was made in Holland, especially at Delft, where the blue ornamented ware called delft was first manufactured. From Holland the art was carried to England, where much delft ware was made. About the middle of the last century, Josiah Wedgwood, an English potter, became very celebrated, and found out how to make many new and beautiful wares. Other potters became noted after him, and now much of the finest pottery comes from England, especially from Staffordshire, where there are many potteries. The making of fine table earthenware is now carried on in the United States at Trenton and Jersey City, N. J., at Liverpool, Ohio, and other places.

The Chinese and Japanese have known how to make pottery from the most ancient times; and the Chinese say that they made porcelain before the time of Christ. Porcelain or china ware had been carried to Europe long before it was found out how to make it, which was not known until the seventeenth century. It had been known for about two hundred years what the Chinese put into it, but the kaolin or white CLAY used had not been found in Europe. In 1711 a man named Böttger, who was trying to find out the secret of porcelain-making for the Elector of Saxony, was one day astonished to find that his wig was much heavier than usual. On asking his servant the cause, he was told that he had got out of hair-powder and had used a kind of white powdered clay to dress his wig with. Böttger examined the clay, and tried it in making porcelain, and was delighted to find that it was true kaolin. A factory was built in Meissen, twelve miles from Dresden, and the porcelain which is still made there is generally called Dresden porcelain. Though Böttger tried to keep the secret, one of his workmen ran away with it to Vienna, where a factory was built in 1720. These two factories have always been noted for fine porcelain, and most of the little groups of painted China figures are made in them. A kind of porcelain was made in France about the same time, but it was not until 1786, when kaolin was found by accident by the wife of a country physician, that much of it was made. The principal French factory is at Sèvres, where much of the finest porcelain is now made. Fine porcelain is also made in Staffordshire, England. Good porcelain is made in the United States at Greenpoint, L. I. and at Trenton, N. J. These factories make chiefly plain table ware, but some fine decorated ware is now made at Greenpoint.

The word pottery is in French *poterie*, which is from the Greek *poterion*, drinking cup.

POUND, a measure of weight, in use in England and the United States. There are two kinds of pounds, the avoirdupois or commercial pound, containing 16 ounces, or 7000 grains, and the Troy pound, containing 12 ounces, or 5760 grains. All common articles are sold by avoirdupois weight, but gold, silver, jewels, and precious stones (excepting diamonds and pearls, which are weighed by the

CARAT) are sold by troy weight. Apothecaries' weight is the same in grains, ounces, and pounds as Troy weight.

The word pound is in Anglo-Saxon *pund*, from the Latin *pondus*, a weight, from *pondere*, to weigh.

Avoirdupois is from the Old English *aver de peis*, goods of weight.

Troy weight is so called from Troyes, in France, where it was first adopted in Europe. The troy ounce is said to have been brought from Cairo during the Crusades.

POUND STERLING, a denomination of money in Great Britain. There is no coin of this name, but the gold sovereign, worth about $4.86, is of the same value. The pound is divided into 20 shillings of 12 pence each. In Saxon times, about A. D. 670, the pound sterling was a pound troy of silver, divided as now into 20 shillings, so that the shilling was then three times as large as now. About the time of Henry II. money began to be called sterling, from the Easterlings or merchants from the Baltic and Germany who visited London, some of whom were probably employed in coining, and it has ever since kept the name. In the early coinage the silver penny or sterling was marked with a deep cross in it so that it could be broken across. When broken into two parts, each was called a halfpenny, and when into four, each was called a fourth-thing or farthing. Larger silver pieces of fourpence were also coined, called from their size greats or groats. The first shillings were coined in the reign of Henry VII. (1504), and the first copper coins in the reign of Charles II. (1665). The guinea, so called because it was made of Guinea gold, was first coined in 1666. It varied in value until 1777, when it was fixed at 21 shillings. None have been coined since 1817, when sovereigns were first issued.

PRAIRIE-DOG, a small animal halfway between a marmot and a prairie squirrel, common on the western prairies of America. It is about a foot long with a tail four inches more, is reddish cinnamon-brown above and yellowish white below, with a head somewhat like a woodchuck's, and strong fore claws with which it digs deep burrows. Prairie-dogs live in villages, sometimes of many thousands, with their burrows close together, extending for miles, and so deep as to make it dangerous to ride among them. They pile up the earth at the mouth in a mound, on the top of which they sit on their hind legs in a comical manner. If anyone approaches they tumble quickly into their holes, but presently return and peep out again with their bright little eyes. Their food is entirely vegetable and their flesh is tender and juicy. Their chatter is somewhat like the yelp of a puppy, from which it is supposed they got their name, for they have no resemblance to a dog. Rattlesnakes often live in the same burrows with them without harming them. The French Canadians call the prairie-dog *petit chien* (little dog) and the Indians *wishton-wish*. It is sometimes called also prairie-marmot. The prairie-dog is a MAMMAL of the order *rodentia*, or gnawing animals.

PRAIRIE SQUIRREL, a kind of marmot or ground squirrel living in the western prairies of America. There are several varieties, of which the best known is the striped prairie squirrel. It is about six inches long with a tail of four inches, is dark brown above and yellowish below, its back marked with eight or nine stripes with yellowish spots. It lives in shallow burrows and feeds on grasses, roots, seeds, field mice, and insects. In Iowa, Wisconsin, and some other Western States it is called gopher, but it is not a true gopher.

The **California Prairie Squirrel** is about eleven inches long with a tail of eight inches, is a mottled black, brown, and yellowish brown above and pale yellow below, and has a white patch on the sides of the neck

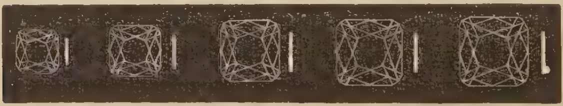
and shoulders. This squirrel does much damage to grain fields and vegetable gardens.

The prairie squirrel is a MAMMAL of the order *rodentia*, or gnawing animal.

PRAIRIE WOLF. See WOLF.

PRECIOUS STONES. Under this name are included all kinds of rare and beautiful stones which are worn as ornaments. They are sometimes called gems, but this name is more properly given to precious stones after they have been cut or engraved. Precious stones are found in different parts of the world, chiefly in the veins or cracks of rocks, in earth which has been washed down from hills, and in the gravel and sands of rivers. In their natural state they are usually rough and shapeless, like worn pebbles, and have to be cut and polished before they show their beautiful colors.

Precious stones may be divided into three classes, according to the materials of which they are made: the CARBON class, the alumina (see ALUMINUM) class, and the silica (see SILICON) class. The only one of the carbon class is the DIAMOND, which is made up of pure carbon. In the alumina class are included all the stones properly called SAPPHIRES, among which are the true sapphire, the oriental RUBY, the oriental emerald, the oriental topaz, and the oriental amethyst. All these are made up of pure alumina, colored in different ways. The silica class includes the OPAL, the AMETHYST, and the AGATES, among which are the carnelian, chalcedony, onyx, sardonyx, and blood stone. These are all made up chiefly of silica.



Proper Sizes of Precious Stones of One, Two, Three, Four, and Five Carats.

Between the alumina class and the silica class are several kinds of stones, which are made up partly of alumina and partly of silica, united with some other things. Among these are the true EMERALD and the true TOPAZ, which differ from the oriental emerald and the oriental topaz. There are also some other stones, such as the GARNET, made up of different things, which are counted among precious stones, though they are not worth much. The PEARL and some other things, such as CORAL, conch SHELL, AMBER, malachite, TURQUOISE, and LAPIS-LAZULI, though used in making jewelry, are not properly precious stones.

The most valuable of the precious stones, and those which rank the highest as jewels, are the ruby, the sapphire, the diamond, and the emerald. The diamond is generally called the most valuable of all stones, but this is an error; a ruby and a sapphire of the same size would be worth more. The sizes of diamonds and other jewels are told by their weights, called CARATS. The sizes of jewels of one, two, three, four, and five carats are shown in the picture. The lines on the sides show the height of each stone. A fine ruby of the size of one carat would be worth about \$450, a sapphire \$300, a diamond \$150, and an emerald \$100.

Precious stones are used chiefly for ornament, but diamonds are used for cutting glass and for cutting other diamonds and precious stones; and diamonds, rubies, and sapphires are put into watches for the machinery to work on. Small bits of precious stones are made also into lenses for MICROSCOPES.

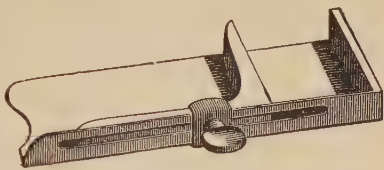
Artificial precious stones are made out of a kind of glass called strass or PASTE, which is made of all colors. Some of them are very beautiful, and can scarcely be told from real ones. A few real precious stones have also been made, but only very small ones.

PRINTING. This art was known to the Chinese as early as the sixth century, but their printing is different from ours. We print from movable types, each of which is one letter, set together so as to form words and lines and pages; and after the printing is done they are distributed, that is, the pages are taken to pieces word by word, and each type put back into its little box; but in the Chinese way, which is called block printing, each page is engraved by itself on a block of wood, and cannot be taken apart. It is not known who first found out how to print from movable types; the Germans say that it was John Gutenberg of Strasburg, but the Dutch say that Laurence Coster of Haarlem was the first to do it, and that Gutenberg, who was Coster's workman, stole the secret from him. Printing types are described in the article TYPE.

Composition. Printing may be divided into two parts: first, the composition, or setting up of the types, and second the press-work, or printing on the paper. The person who sets the type is called a compositor. He stands before his case, a high frame which holds two shallow trays, divided into little boxes. One of these trays, called the lower case, lies in front on the top of the frame, and slopes a little forward; the other, called the upper case, is placed behind the lower case, and is a little more sloping. The lower case has fifty-four little boxes, in twenty-six of which are kept the twenty-six small letters of the alphabet, and in the others the figures, the punctuation marks, and little pieces of lead called spaces. The lower case boxes are of different sizes, because there are many more of some letters used than of others. In common printing only one *z* is used to sixty *e*'s and forty *a*'s and *o*'s. The upper case is divided into ninety-eight little boxes, all of the same size, which contain large and small capital letters and spaces.

Italic or slanting letters (see ALPHABET) are kept in other cases.

In setting type the compositor uses a composing-stick and a rule. The composing-stick is a little steel frame or box, with a bottom, one side, and two ends. One of the ends is movable and is fastened by a screw, so



Composing Stick.

that it may be set to any width. In composing it is set just the length of the line, and it will hold about fifteen lines of the type used in this Cyclopædia. The rule is a piece of thin smooth steel of the length of the line and the height of the type. When the compositor is ready to set type, he takes the stick in his left hand, holding it with the bottom toward him with his thumb, which he puts inside of it, and places the rule in it against the side; he then picks up the type, one by one, and sets them up against the rule, beginning at the right, and going toward the left, and placing the type with the nicks, which he feels with his fingers, outward. He does not look at each type, for he knows by long use in which box each letter is. When the line is filled up, he looks at it to see if the words are spaced right—that is, if all the words are the same distance apart, and if not he arranges them as they ought to be. This is called "justifying."

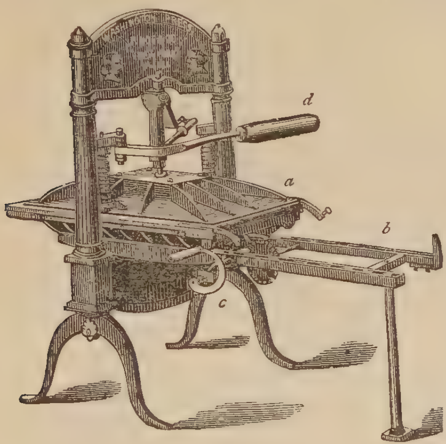
When the line is justified, he takes out the rule and places it in front of the line just set, and then goes on to set another line. Types are sometimes set "solid" and sometimes "leaded." When solid, they are set up in the stick one line on top of another, so that the types of one line touch those of the next one; when "leaded" a thin slip of lead is put between the lines to keep them apart, so that when printed they have a more open look.

If you try to read a line of type you will see that the letters are turned the wrong way. This is because you look at them from the bottom. If you turn the line over, end for end, so that the right side will come on the left, and print from it, you will see that the letters will all come right, and that the line will read from left to right, just like a printed page. When the stick is full—that is, when as many lines are set up in it as it will hold, the compositor empties it by sliding off the type on to a "galley." Galleys are long narrow trays, made generally of brass, with a rim on the two sides and the upper end to keep the type in place. Each stickful of type is emptied into the galley one after the other until it is full. A galley will hold about eleven stickfuls of the type of this Cyclopædia, or three columns. When the galley is filled the type is fastened tight with wedges so that it cannot be shaken or moved out of place. The face of the type is then inked by rolling over it a little roller covered with printer's ink. This has to be done carefully, for if there is too much ink on the roller, it will fill up the type and make them blot. A sheet of paper about as large as the galley is now laid on the type, and a heavy roller covered with a piece of woollen blanket is rolled over it, or it is pressed in a proof-press. When the paper is taken up a copy of the type will be found printed on it. This is called a "proof." The proof reader reads the proof carefully and marks all the mistakes in it, when it is sent back to the compositor, who corrects the errors in the type. A second proof is then taken, and the proof reader reads it to see if all the mistakes which he marked have been corrected. Sometimes several proofs are read. When it is found out that the type is right, the type in the different galleys is made up into pages, when it is customary to read another proof called a page-proof, so as to be sure that everything is correct. As the pages are finished they are put upon the "imposing stone," a table with a thick smooth marble top, and made up into forms.

A form is composed of as many pages of a BOOK as can be printed at once on one side of a sheet. The pages, which are so arranged that the sheet printed from them will come right when folded, are put together in an iron frame called a "chase," and tightly wedged so that none of the type can drop out when the form is lifted up from the imposing stone. This is called "locking" the chase. The form is then "planed"—that is, the surface is made even by going over the face of the type with a wooden block called a "planer," and forcing them down by blows of a mallet. It is then ready for printing.

Printing Press. There are many kinds of printing presses, but I shall tell about only three kinds: platen presses, cylinder presses, and rotary machines. Platen presses have a flat bed for the types, which are impressed by a flat platen. One kind of platen press is shown in the picture of the Washington press. In this the press is seen shut up ready to print, the form of type being under the platen, *a*. When the press is open the bed lies outside of the platen on the frame *b*. When the printer is ready to print, he rolls an inking roller over the form so as to cover the face of all the type evenly with ink. He then spreads a sheet of

damped paper on the under side of the tympan, a thin wooden frame so fastened with hinges on the right side of the bed that it can be raised up and shut down on it. The tympan has a kind of cover called the frisket, a frame made of thin iron which will shut down on the tympan so as to hold the sheet of paper and keep the ink from soiling its edges. After spreading the paper smoothly, the printer shuts down the frisket on it, which covers all the paper except the part to be printed on. He then turns down the tympan on to the form, which brings all the part of the paper uncovered by the frisket on to the face of the type. If you now look at the picture, you will see a little crank or handle, *c*, at the side of the press. The printer turns this round and the whole bed of the press, with the form of type and the tympan and frisket, moves along until it comes under the platen *a*. The platen is a heavy and strong frame of iron, a little larger than the form of type. The under side of it is smooth and flat, so that it will press evenly on all the type. As soon as the form comes under the platen, the printer takes hold of the lever or arm, *d*, and pulls it toward him. This brings the platen down very hard on the back of the tympan, and presses the sheet of paper to be printed down on to the face of the type. The printer then raises the platen from the type by pushing back the lever, and turns the crank backward, which brings the form and bed out from under the platen and into its place again. He next turns back the tympan and then the frisket, takes the printed sheet off the tympan, and lays it on a table, and is then ready to print another sheet. This kind of hand press is not much used now in book-printing. The platen presses now used go by steam, and the bed holding the form of type is pressed up against the platen, instead of the platen being brought down on to the type.

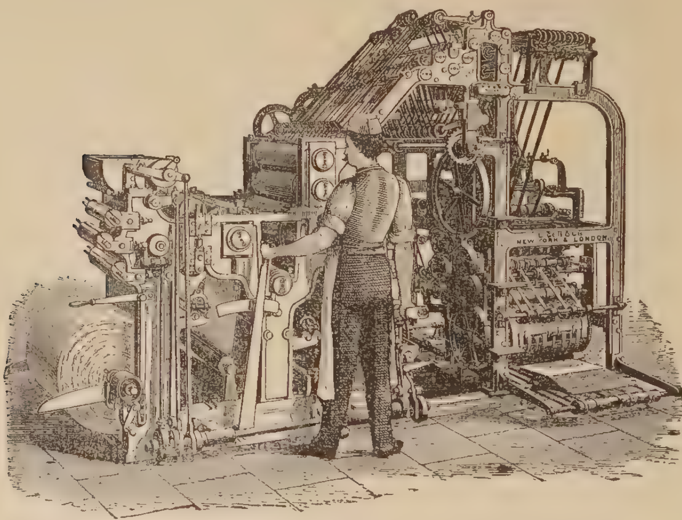


Washington Press.

In the cylinder press there is no platen, but the bed, which is flat, is shoved forward and backward under a great turning cylinder or roller, covered with a soft blanket or rubber sheet, which rolls over the type and presses the paper down on to it.

The rotary machine, on which the great daily newspapers are printed, has no flat bed like platen and cylinder presses. The printing is done by stereotype plates which are not laid flat, but are bent round and fastened on to the cylinder itself. The cylinder is just large enough to hold the plates so that in turning round once it prints one side of the sheet. The paper is pressed against the type cylinder by a smaller roller which rolls on it and turns at the same time. In the best newspaper presses, the paper, instead of being put in, or "fed" as it is called, in sheets one at a time, is printed from a great roll, and the sheets cut off afterward. In the web perfecting press, so called because the paper is in a large web-roll two

to four miles long, the roll is put at one end of the press so that it will turn round easily, and the end of the paper is unrolled and drawn in by the press as fast as it is needed to print on. It moves at a speed of about nine or ten miles an hour. It goes down first between one cylinder with the plates fastened around it and another cylinder that pushes the paper against the letters. This prints one side of the newspaper. The web next passes between two more cylinders, which print the other side, and then between a third pair of cylinders, which make several cuts across the web at the right places, dividing it up into parts, each part being a newspaper fully printed. The papers are not thus fully cut off, and the web moves on a little further until it comes to a set of rollers which turn faster than any of the others. By these each newspaper is separated from the one next to it and hurried along to the folding machine, where it is folded into the shape wanted far more neatly than



Hoe's Web Perfecting Printing Press.

can be done by hand, at the rate of about three hundred a minute. Newspapers to be sent by mail are folded differently from those which are to be sent round by carriers, but the machine can be made to fold them in any way. The picture gives but little idea of the great size of this wonderful machine, which fills a space about twenty-four feet long and six feet wide. It is made up of a great many parts, all of which work together so perfectly that the machine needs but little care when printing. Only about twelve hundred sheets could be printed by a man on the old-fashioned hand press in a day, but web-machines will print from 5000 to 50,000 sheets in an hour, and fold them all. Web-machines began to be used first in 1853; since that time great improvements have been made in them by Applegate of London, Marinoni of Paris, and Hoe of New York. In a new press, made by R. Hoe & Co., of New York, for the New York *Herald*, the paper, which is double the

width of a newspaper, is fed from three rolls, and will produce 90,000 four-page papers, all pasted, folded, and counted, in an hour.

Books are generally printed in this country on the Adams press, and in England on the Albion press, in which the type is laid on a flat bed and pressed upward against the platen. Fine books, with fine illustrations, and magazines are printed on cylinder presses. Job work is largely done in this country on the Gordon press, and in England on the Cropper press. When all the sheets of a book are printed, they are dried by hanging them across wires in a drying-room. The printed sheet is then quite rough, the type having made little dents all over it. To take these dents out, the sheets are put, after drying, into a press where they are pressed very hard between sheets of smooth pasteboard. This makes the paper smooth, just as you see it in any bound book. After pressing, the sheets are ready to go to the binder. (See BOOK.)

Stereotype and Electrotype Plates. Books are now seldom printed from the types themselves, but from plates made from the type. A plate has a face just like the type, but its back is solid lead, so that it cannot be taken apart. There are two kinds of plates, stereotype plates and electrotype plates. In making stereotype plates one or more pages of type are locked in a chase. The face of the type is then oiled, and covered with a mixture of plaster of Paris (see GYPSUM) and water, about as thick as cream, which is kept from running off by a raised rim. The oil prevents the plaster from sticking to the type, and in a short time it becomes so hard that it may be taken off, when it will be found to be an almost perfect mould of the type. This is now trimmed smooth on the back and edges with sharp knives and placed in a shallow iron pan so made that when it is put into a vessel of melted type metal the metal flows in and fills the pan. The pan is then taken out and cooled, and the plate, when cleared of the plaster, which is broken off from its face, will be found to be about a quarter of an inch thick. It is then carefully trimmed, and mended where letters are broken, and the back is shaved down until the plate is all over of the same thickness. It is then fastened to a wooden back which is just thick enough to make the whole as high as a type, and is ready to be made up into a form with other pages. Stereotype moulds for newspapers are generally made of a kind of PAPIER-MACHÉ instead of plaster. Plates can be made much quicker in this way, it taking only about half an hour to cast a newspaper page.

In making electrotype plates, the form is made up in the same way as in stereotyping. A sheet of wax fastened in an iron plate is laid down on the face of the type, and pressed on it until a perfect mould of the type is made in the wax. The mould is next taken off and covered with a thin coat of black-lead, when it is put into a bath containing a solution of copper, which, by means of ELECTRICITY, as told about under METAL WORK, is made to fasten itself in a thin film on the black-lead. When this has grown to be about as thick as a sheet of writing paper, the mould is taken out of the bath and the copper taken off from it. The shell, as it is called, looks like a sheet of copper with all the letters punched up, but the face is an exact copy of the type. It must be backed before using, the same as the stereotype plate.

The word printing is for imprinting, which is from the Latin *imprimere*, to stamp.

PRUNE. The best prunes come from France, where several kinds of plums are raised especially for making prunes. The chief kinds used are the quetsche plum, sometimes called German prune, and the

Juliana plum. They are dried in ovens which are slightly heated, and into which they are put several times. The finer kinds are made from a larger and sweeter plum, called the Catherinea or St. Catherine, and are more carefully dried than the common ones. They are the ones which come packed in ornamental paper boxes, the others being usually put up in wooden boxes and jars. The most French prunes come from Brignolles and Bordeaux. French prunes are generally eaten by hand and not cooked as preserves. Cooking or stewing prunes are brought mostly from Bosnia and Servia; those from Servia are dried over wood fires and are apt to be a little smoky. A few come from Hungary and Bohemia, but they also are smoky.

The word prune is from the Latin *prunum*, Greek *prounon*, a plum.

PUMICE, a kind of mineral thrown out from volcanoes. It is very hard, brittle, and porous (full of little holes), and so light that it will sometimes float on water. It is of various colors, such as white, gray, yellow, brown, and black, but is commonly grayish white. Pumice is used both in the lump and ground to powder for polishing wood, stones, metals, ivory, glass, and for rubbing down parchment, vellum, and some kinds of leather. It is brought mostly from Italy and Germany.

The word pumice is from the Latin *pumex*, pumice-stone.

PUMP. In the article BAROMETER is told how the pressure of the air on the surface of water will drive the water up into a tube from which the air has been sucked out. The common suction pump works on the same principle, as will be seen from the pictures, which show a pump in a well, the surface of the water being at *c*. In Fig. 1 the handle is raised as is always done in beginning to pump. This pushes the piston *a* down in the tube toward the water. If the piston were solid, it would push the air down before it, and this would push the water down too; but it has a VALVE

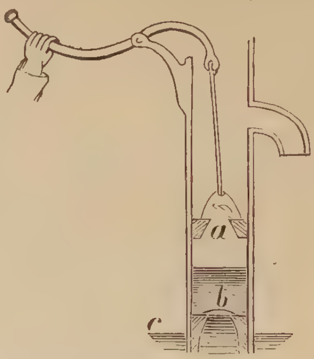


Fig. 1.—Suction Pump.

which opens on the top like a little door and lets the air pass up through it. The handle of the pump is next pushed down, which brings the piston up. As soon as the piston begins to move upward the pressure of the air above shuts the valve so that the air which went up

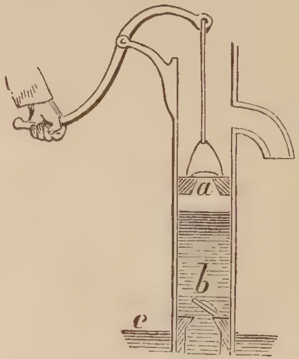


Fig. 2.—Suction Pump.

through it cannot get back again. This leaves some room below the piston. There is another valve *b* in the lower part of the pump, which in Fig. 1 is shown shut. When the piston moves up, as in Fig. 2, the

pressure of the air on the surface of the water *c* forces open the valve *b*, and the water passes up into the pump and fills the space where the

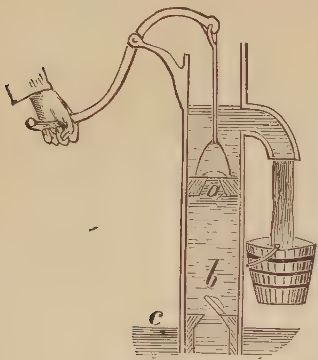


Fig. 3.—Suction Pump.

air was. If the handle of the pump be now raised again, the piston *a* will go down below the rest of the air and into the water, which passes up through the valve *a*. When the piston goes down, the valve *b* closes so that the water which passed up cannot go back again, and the next

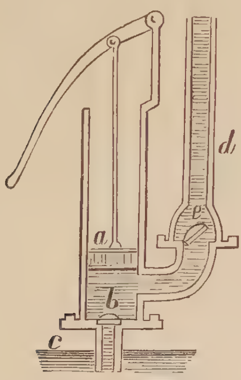


Fig. 4.—Force Pump.

time the piston goes up the water is raised so high that it flows out of the spout, as in Fig. 3. Thus, the piston draws out the air in the pump, and the pressure of the outside air on the surface of the water in the well at *c* forces the water up the pump.

The **Force Pump** is much used for forcing water up into the higher stories of dwellings. In this pump, which is shown in Fig. 4, the piston *a* has no valve in it, but fits tightly in the tube. When it is raised up the air above it is pushed out, and this leaves an empty space below, between the piston and the water;

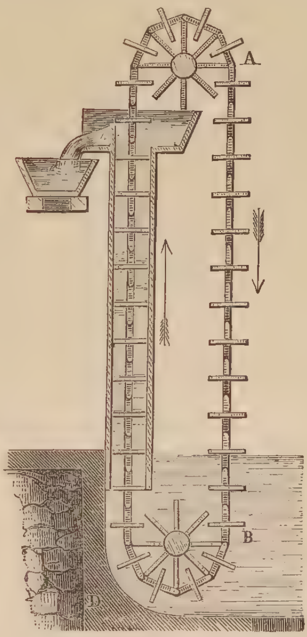


Fig. 5.—Chain Pump.

or rather it would leave an empty space if the water did not rush in to fill it. Just as soon as the piston goes up the valve *b* opens, and the water rushes up from the well and fills the tube below the piston. If now the piston be brought down by pushing down the handle of the pump, the water is pushed down again. This closes the valve *b*, so that the water cannot get back into the well again; so it is forced to go

up through the valve *e* into the pipe *d*. When the piston is raised again the water in *d* would be pressed back into the pump again by the air above, if it were not for the valve *e*, which closes and stops it. The valve *b* then opens again and lets in more water; the piston comes down again, the valve *b* closes again, and the water again opens the valve *e* and forces the water above up the pipe *d*, and so it goes on until the water in *d* is forced up as high as wanted, when it runs into a tank made for it.

The **Chain Pump,** Fig. 5, is an endless chain, with little cups or round flat pieces on it, which passes through a pipe just large enough to fit the cups. The chain goes over a wheel or barrel A at the top, which is turned round by a WINCH, and around another wheel B under the water. The water is carried up the pipe by the cups until it is high enough to pour out of the spout, as in the picture. The arrows show the way the chain moves round.

The word pump is found in many languages; in French it is *pompe*, in Italian *pompa*, in German *pumpe*, in Swedish *pump*, and in Danish *pompe*. It is perhaps an imitation of the sound of splashing water.

PUMPKIN, the fruit of a plant of the GOURD family, to which the squash also belongs. The pumpkin and the squash probably grew first in America, though some writers think they were known to the Romans, who had a vegetable somewhat like a pumpkin, but was more likely a melon of some kind. The Mexicans grew very large pumpkins, and pumpkin and squash seeds have been found in Peruvian tombs. The pumpkin plant is a vine which often runs more than twice the length of a man, and which has large, yellow, bell-shaped flowers. The fruit of the common field pumpkin is at first green, but when ripe is bright orange; but there is a kind which is dark green when ripe, and another which is striped green and yellow.

Pumpkins are now used chiefly for feeding cattle. They are used in New England for making pies and as a boiled vegetable like squash, but some kinds of squashes are preferred to them by most people. Boys make jack-o-lanterns out of pumpkins by cutting off the top, scraping out the soft part, and cutting eyes, nose, and mouth on one side. When a lighted candle is put in one of these at night, it looks much like a fiery face.

The word pumpkin was spelled pompion in old times, and is from the Old French *pompon*, Greek *pepon*, a melon.

PUTTY, a cement used by glaziers to fasten panes of glass into window frames, and for other purposes. It is made of whiting (see CHALK) and linseed oil. The whiting is dried, pounded, and sifted, and stirred into the oil. When it is stiff enough it is worked by hand, or with a hammer, on a board until it is smooth.

The word putty is in French *potée*.

Q

QUAGGA, a kind of zebra, found in South Africa. It is about four feet high at the shoulders, has a small head with short ears, a short upright mane, and a tufted tail. On the neck and shoulders it is dark brown beautifully striped with black, the back and hindquarters lighter brown with stripes, and the lower parts white without stripes. It thus differs from the real zebra, whose legs are striped like its body. The quagga is found in large herds, generally with gnus and ostriches, but not with zebras. It is swift and strong, and when domesticated good-natured and obedient. Its flesh is coarse, but is eaten by the natives.

The word *quagga*, sometimes spelled *quacha*, is supposed to be South African.

QUAIL. There are several kinds of quails in the United States, but the one best known is the common quail, or Bob White, so called because the notes of the male birds in the breeding season sound like "Ah, Bob White." This bird is brownish-red marked with gray on the back, and whitish marked with brown below. It is called quail in New England wherever the ruffed grouse is called partridge, and partridge in the Middle and Southern States wherever the ruffed grouse is called pheasant. But some other name ought to be given to it, as there are no real quails nor partridges in America. Quails live in flocks and usually have a leader whose call they follow. They spend their time usually on the ground, seeking their food, which is mostly seeds, berries, and insects, among the leaves, and seldom fly up into trees excepting when frightened. They rest at night on the ground, sitting together with their heads outward, so that they can each fly in a different way if disturbed. They lay ten or fifteen pure white eggs, and raise only one brood each season. Many quails are caught in snares and nets every year, and sent to our markets. The flesh is white, tender, and juicy, and much prized for food.

The **European Quail,** which is a little smaller than the bird called quail in this country, lives in Africa in the winter and in Europe in the summer. Every spring great flocks of them cross the Mediterranean and spread all over Europe, going back to Africa in September. In the Greek Islands they sometimes come in such great numbers that the sky is said to rain quails. They are so tired after their long flight that they often fall to the ground, and thousands are sometimes found drowned along the shores, which have fallen into the sea on their way across. The quail is a very quarrelsome bird, and in ancient times it used to be trained to fight like the game cock. Many are still trained in this way in the East, and made to fight for amusement.

The quail belongs to the order *rasores*, or scratching BIRDS, and to the partridge family.

The word quail is in Old French *quaille*, and in Italian *quaglia*, from the Middle Latin *quaquila*, so called from its cry.

QUARTZ, the common name of SILICON oxide or silica, the most abundant of all minerals. When pure it is found in beautiful crystals,

as clear as ice or glass. It is so hard that it will scratch glass and strike fire against steel. When quartz is of a violet color it is called AMETHYST. Other kinds of quartz are called AGATE, carnelian, chalcedony, FLINT, and JASPER. Clear quartz or rock crystal was once much used for vases, cups, and ornaments, but glass, which can be cut much easier, has now mostly taken its place.

The word quartz is from the German *quarz*, rock-crystal.

QUICKSILVER. See MERCURY.

QUINCE, the fruit of a tree which grows in mild climates, and which belongs to the same family with the pear and the apple. The quince tree is little more than a shrub, though it sometimes grows nearly three times the height of a man. The flowers are white or rose-color, and the fruit is usually pear-shape, but some quinces look more like an apple. Quinces are not good to eat raw, but are usually preserved, or made into tarts, marmalade, or jelly. They have a fine flavor, and are used to season other preserves. A drink, something like cider, is also made from them. Quince seeds have much mucilage in their skins, and jelly is sometimes made from them and the parings of the fruit. A dressing for the hair, called bandoline, is also made from the mucilage, mixed with alcohol and perfumed. The quince was known to the Romans in Cato's time, and pictures of the tree are to be seen in paintings on the walls of Pompeii. Some think that the golden apples of the Hesperides were quinces.

The word quince is in French *coing*, and is from the Latin *cydonia*, Greek *kudonion*, so called from the town of Cydon, in Crete, which was noted for fine quinces.

R

RABBIT. The common tame rabbit of the United States was brought from Europe, where it is found wild. In its wild state it is always grayish-brown on the back, and whitish below; but tame rabbits are of different colors, usually black, gray, sandy, or white. In Europe rabbits live in large colonies called warrens, in burrows dug deep into the ground. They usually hide during the day, coming out at night to eat, and they often do great damage by gnawing the bark off young trees, and by spoiling growing crops. Many are caught every year in snares and traps, or by pouring water into their warrens and forcing them to run out, when they are caught by dogs. Another way of catching them is by sending a FERRET into their holes. Their flesh is very good for eating, and their fur is much used for making felt HATS. The skins, too, are made into glue and size. Furriers sometimes dye and dress rabbit furs so that they can scarcely be told from ermine, mink, minever, or other costly furs. The wild gray rabbit of the United States is more like a hare than a rabbit in its habits, as it does not live in burrows, but makes its nest in thick bushes, or in holes in trees. It is much hunted, its flesh being juicy and sweet.

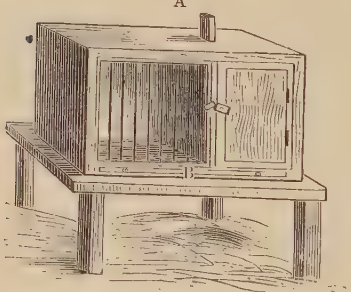
Rabbits make pretty and interesting pets, and are very easy to raise. There are a good many fancy kinds sold by dealers, some of which have large lop ears that hang down to the ground, while others have one ear standing up and the other hanging down. Some of these are sold for high prices, but they are no better for pets than other rabbits, and are sometimes much more troublesome, as they are apt to be sickly. The strongest and healthiest rabbits are those which are nearest in color to the wild rabbit, then the black or black and white, and after them the sandy and the gray and white.

The male of the rabbit is called a buck, and the female a doe. A pair will increase very fast, as they will have young six or seven times in a year, and four to six each time. In buying young rabbits, always take the largest ones where there are the fewest in a litter. The best time to get them is when they are about six weeks old; keep them in pairs in separate boxes until they are about four months old, and after that give each one a separate house to live in.

The rabbit house, or hutch as it is commonly called, should stand in a dry place, where it can have plenty of air. The loft of a barn or shed is a good place. Each hutch should be set on a stand about three feet high, as shown in the picture, which gives the form of a very good kind of hutch. It should be made about four feet long, two feet high, and a little deeper than it is high; and be divided into two parts, a living-room and a bedroom. Each of these should have a door in front, the one belonging to the living-room being open and covered with wires. There should also be a door between the two rooms, which is commonly left open, but may be closed by pushing down the slide A. The bottom should be made of a smooth board, so that water will run off from it, and in front should be a strip of wood, B, which may be taken out

so that the bottom board may be cleaned, which should be done every day. All parts of the hutch which are easily gnawed should be covered with tin, as rabbits have sharp teeth and will often eat their way out of a hutch in a single night.

Rabbits should be fed regularly, and three times a day. Young rabbit-keepers often lose many of their pets from neglect. At first they feed them too much, and afterward they forget them or feed them irregularly, and they are surprised in a short time to find them sickly and moping. Rabbits need two kinds of food, dry food, such as oats, wheat, and buckwheat, with bran



Rabbit Hutch.

and dry clover; and soft vegetable food, such as the tops of carrots and parsnips, cabbage, parsley, and fine grass and fresh clover. They should generally have more dry than juicy food, and to very young rabbits only a very little juicy food should be given. If fed properly and kept in good dry hutches, rabbits will keep bright and healthy, but if not rightly cared for they will show it very quickly.

Rabbits increase so fast that if there were not many kinds of animals that prey upon them, they would soon become a pest. This has happened in Australia and New Zealand, where there are few flesh-eating animals. Until 1851 there were no rabbits in either of those countries. A gentleman who visited England carried back with him a cage full, and for a year or two sent their young round as presents to his friends. They increased so fast that thousands of acres have been devastated by them and many farmers ruined. Many plans have been tried to get rid of the pest, but with little success. It is said that fifteen to twenty million rabbit skins are sold every year in New Zealand alone (see THISTLE).

The rabbit is a MAMMAL of the order *rodentia*, or gnawing animals, and of the hare family.

The word rabbit is in provincial French *rabotte*, and in Dutch *robbe*.

RACCOON. The common raccoon is as large as a small dog or fox, and is brownish-gray, with black or brown markings. It has a sharp nose, a bushy tail, and strong claws with which it climbs trees. Raccoons usually lie in their holes in the daytime, and prowl around at night in search of food. They feed mostly on small mammals, such as rabbits and squirrels, on birds and eggs, frogs, shell-fish, insects, roots, and nuts; but are very fond of ripe corn, and often do much damage in cornfields. They are very skilful in opening oysters, biting off the hinge and scraping out the meat with their paw. They also watch the turtle lay its eggs in the sand, and steal and eat them as soon as it is gone.

The raccoon is found almost all over the United States, but most abundantly in the Southern States. The negroes have great sport in winter in hunting it with dogs. When a "coon," as they call it, runs up into a tree, they cut it down if they cannot shake the animal off, and when it falls the dogs catch it. Raccoons are sometimes tamed, and they make very cunning pets, following their master like a dog. The flesh of the raccoon tastes somewhat like pig, and is very good eating.

The raccoon is a MAMMAL of the

order *carnivora*, or flesh eating animals, and of the bear family.

The word raccoon is probably from the French *raton*, a little rat or raccoon.

RADISH, a garden plant, cultivated for its root, which is eaten raw as a relish. It is supposed to have first come from western Asia, but it was brought to America from Europe, where it has been raised from the most ancient times. The root is made up mostly of water and woody fibre, and is not worth much for food. Herodotus tells about a kind of radish that was used by the builders of the great pyramid or pyramid of Cheops. Pictures of it are on the walls of the temple of Karnac.

The word radish is from the Latin *radix*, a root.

RAFT, a float made of logs or beams and planks fastened together. Sometimes rafts are built especially to carry heavy things, such as large masses of stone, down a river or along the sea-coast; and they are sometimes made to save people and goods on in cases of shipwreck. Rafts are used, too, as stagings by ship carpenters in repairing vessels, and sometimes in building floating bridges across streams.

Another kind of raft is made for the purpose of conveying logs and other timber from one place to another, generally from the upper waters of a river, where the logs are cut, to the lower parts, where they are sold. Very large rafts of this kind are often seen on the river Rhine, in Germany. Great numbers of trees are cut down every year along the little streams which empty into the upper parts of the Rhine. These are made into small rafts and floated down into the Rhine to the village of Namedy, where the river is wide. There they are all fastened together and made into one large raft, sixty or seventy feet wide, or twice as wide as an ordinary house, and more than ten times as long. The raft is made of several layers of trunks of trees, placed one above the other and fastened together with chains. On the top is built a platform of oak and pine timber, and on this are houses for the owner and his workmen. There are often fifteen or twenty of these little houses, so that the raft looks like a floating village as it goes along. There are sometimes seven or eight hundred rowers and other workmen on one of these rafts, as well as poultry, pigs, and cattle. Such a voyage down the Rhine is quite costly, as it takes much time, and a great deal of food is needed for so many men. It requires, too, a great deal of skill to manage so large a float, as the river is full of rocks and shoals, and has many windings in it. Such rafts are often sent down rivers in this country, especially in the Northwest, where timber is plentiful. These rafts are floated in pieces down the streams to the great lakes, where they are put together into large ones, and towed to different places. Many, too, go down the St. Lawrence.

The word raft is probably from the Danish and Swedish *raft*, a beam or rafter.

RAGS. All kinds of worn-out woven goods, no matter how small the pieces, are valuable in the manufacturing arts. Cotton, linen, and hemp rags are made into PAPER; and woollen and worsted rags, if in good condition, are torn to pieces by machines, mixed with fresh wool, and re-spun, while the refuse is ground into powder, dyed various colors, and used by makers of PAPER HANGINGS as flock. Great quantities of rags are brought to this country every year for these uses; and great quantities also are collected by the street scavengers and sold to the junk dealers, who sort them and sell them to the paper makers and woollen manufactures.

The word rag is from the Anglo-Saxon *hracian*, to tear.

RAIL, the name of a family of birds that live in marshes and on the borders of rivers, their food being crustaceans, worms, slugs, insects, and the seeds of water plants. The largest American rail is the fresh-water marsh hen, found along the coast of the Middle and Southern States. It is about eighteen inches long, olive-brown with brownish-black stripes on the back, with neck and breast reddish-chestnut, whence it is sometimes called red-breasted rail.

The **Salt Water Marsh Hen** or clapper rail is not quite so large, and has a neck and breast more yellowish. It is found from New York to Florida.

The **Virginia Rail** is still smaller, being only about ten inches long. Its color is much like that of the red-breasted rail.

The **Carolina Rail**, about nine inches long, is greenish-brown marked with black above, and ashy-blue below. It is found from New York southward, and also on the Pacific coast. All the rails are esteemed for their flesh.

The rail belongs to the order *grallatores*, or wading birds.

The word rail is from the Old French *raale*, from *raller*, to rattle in the throat, to make a cry.

RAILROAD or **RAILWAY**. Rails were used on roads for wagons drawn by horses much before this century, but the first real railroad was the Stockton and Darlington, in England, opened in 1825. This was built for hauling coal and other freight by horse power, and it was nearly finished before anyone thought of its being used to carry passengers. When is was opened one passenger coach only was provided, a rude box-like machine, named the Experiment, shown in Fig. 1. It had a row of benches on each side, and a long table in the middle, and was drawn by one horse, making the journey of twelve miles in two hours; but it was soon found too clumsy and lighter ones were built.

When the railroad was opened a long train was drawn by a locomotive built by George Stephenson, at the rate of about twelve miles an hour, but for several years the principal work was done by horses. The

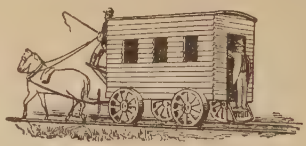


Fig. 1.—The Experiment, first Railway Passenger-Car.

horse drew the train along the level until a descending grade was reached, where he was unharnessed, and trotting around to the other end of the wagons, he stepped into the rear one, which had a floor only a few inches above the track and was provided with a hay-rack, and so rode down the incline. People were then opposed to the use of the locomotive; some said it would poison the air, that horses would no longer be of use, that cows would not give milk, nor hens lay, that houses would be burned by sparks, and passengers killed by boiler explosions. But the locomotive finally prevailed, and regular passengers trains were run on the Stockton and Darlington and on the Liverpool and Manchester railways after 1829, drawn by Stephenson's LOCOMOTIVES. Soon after this railroads were built in the United States, and we have now more miles laid than in all the countries of Europe put together.

Survey of Roads. Before beginning to build a railroad between two places, careful surveys of the routes which the road might follow are made, to find out which is the best and cheapest way. The manner in which a road is built depends much on the use to which it is to be put. If there is to be but little travel on it, it will be cheaper to follow the natural shape of the ground as

nearly as possible, but if there are to be many trains and they are to be run very fast, it will be necessary to make the road as nearly straight and as nearly level as possible. This will cost much more, especially if there are hills to be cut away or tunnelled through, rivers to be bridged, or valleys filled up. All this is the business of the civil engineer, who draws the plans and calculates the cost of the road.

Grading. In building a railroad the first thing to be done is to make the road-bed, that is, the bank of earth, gravel, etc., on which the ties and rails are to be laid. This is called grading. Where the road-bed is piled up above the surface it is called an embankment; where it is made by cutting through a hill, leaving it open at the top, it is called an excavation; and where it is cut through a hill so as to leave the earth arched overhead, it is called a TUNNEL. Where the road crosses low places that are the natural water drains, small tunnels called culverts built of stone or brick, are constructed for the water to flow through; and at road crossings open places called cattle-guards, to keep cattle from going down the track, are sometimes built. When the road-bed is made it is ballasted, that is, covered with a layer of gravel or broken stone called ballast, for the ties to rest on. The grade of a road is the rise or fall of its bed; where it is perfectly flat it is said to be level; where it rises in any part above the level so as to run up hill, it is called an up grade; and where it falls below the level, so as to run down hill, it is called a down grade. The turning of a road out of a straight line is called a curve.

Superstructure. Everything built on the road-bed, including the ties or sleepers, the rails, and their fastenings, is called the superstructure (from Latin *superstruere*, to build upon). The ties, which are commonly of white oak, hemlock, yellow pine, or chestnut, are laid upon the road-bed, and the spaces between are filled up with ballast. Rails were formerly made of iron, but STEEL rails, which last longer and are much less liable to break, are now generally used. They are rolled out while red-hot between great iron rollers, in mills made for the purpose, and are usually thirty feet long, or five times as long as a man. There are many different shapes of rails, but the kind chiefly used in the United States is the T rail, made like the letter T turned upside down.

Fig. 2.—T Rail.

Rails are fastened to the ties by spikes driven in by their side, and the two ends of different rails are held together by two flat pieces of iron, C, called fish-plates, one on each side, fastened by four screw BOLTS which pass through holes in the ends of the rails, AA. As iron swells when heated, and contracts or shrinks when cold, rails are a little longer in the summer than in winter. The rails of a railroad are, therefore, always laid a little way apart at the ends, as shown in the picture at B; for if they were put close together there is danger that the heat will swell them and push them out of place so that they will tear up the track. For the same reason the screw holes have to be made longer than they are high, so that the screws can move backward and forward a little when the rails become heated. The width between the rails is called the gauge. The usual gauge of railways in this country is four feet eight and a half inches. This was the width of the first locomotive engine

B

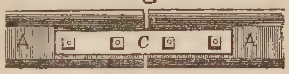


Fig. 3.—Fish Joint.

brought here from England, and the same gauge has been kept up almost everywhere, although we have some railroads with a wider gauge, and some in the West have a guage of only three feet. In laying rails around curves the outer rail is always put higher than the inner one. If they were laid of the same height the last car of a train going round a curve would be apt to be thrown off the track; but when the outer rail is higher the weight of the cars comes on the inside of the curve and keeps them from falling outward.

On the best roads two sets of rails are usually laid, forming what is called a double track, one of which is always used by trains going in one way and the other by trains going the other way; and some roads which do a great deal of business

Fig. 4.—Railroad Switch.

have three and even four tracks. But many have only one track, and such roads have switches or turnouts built where trains going different ways meet, so that one train can turn off on to a side track and let the other one pass, when the train thus switched off can come back on to the main track again. In Fig. 4 A B and C D show the main track, and A E and C F the switch or turnout.

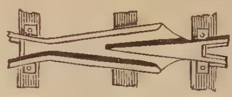


Fig. 5.—Railroad Frog.

All these rails are fastened to the ties excepting the parts between *a* and *b* and *c* and *d*, which are made so that their ends, *b* and *d*, may be moved backward or forward by pushing or pulling the switch bar, S. As the rails are placed in the picture, a train running from A C downward would pass off the main track on to the switch. Two guard rails, *r x* and *r x*, are put opposite where the switch crosses the main track, to keep the wheels from slipping off when they cross on to the pointed piece, O, which is called a frog. The shape of the frog can be seen in the larger picture (Fig. 5). If the train is to be kept on the main track the switch is moved to the other side, so that the ends *b* and *d* fit on to the main track.

Rolling Stock. This is everything which rolls over the road, including locomotives and tenders, passenger, baggage, and freight cars. The locomotive is told about under its own head. Passenger cars on European railways differ from those used in this country, being made like three or four stage-coach bodies put together, with doors opening into each on the side. They have no end doors, and there is no way of going from one car to another excepting by walking along a foot-board on the outside, as shown in Fig. 6. These cars, or carriages, as they are called, are about half as long as American cars, and have only four wheels, like a common carriage. American cars are usually forty-five to sixty feet long,

and are run on trucks (called bogies in England), one at each end, and each truck having from four to eight wheels. The common truck with four wheels, two on each side, is shown in Fig. 7. It is made up of the truck-frame, A, and two pairs of wheels, D D, and is fitted with strong India-rubber springs E E E. The parts marked B B are called axle-guards. The body of the car sits on C, and is so fastened that the truck can turn under it like the front axle of a common wagon. The brakes on the wheels are shown at R R. The wheels do not turn on the axle, but are fixed tight to it, so that when the wheel turns around the axle turns also.

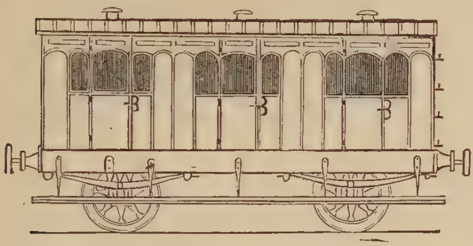


Fig. 6.—English Railway Coach.

In the United States railway trains are better equipped in many respects than on European railways. Parlor, sleeping, and dining cars were first used here, but many foreign railways have now adopted them. Our trains run faster, too, than on European railways, especially those on the continent. The fastest time made in England is about 57 miles an hour. In 1891 a train on the Philadelphia and Reading Railroad ran twelve miles at the rate of nearly 83 miles an hour, and one mile is said to have been run at the rate of 90 miles. A train on the New York Central Railway also ran from New York to Buffalo, $436\frac{5}{8}$ miles, at the rate of $61\frac{1}{2}$ miles an hour, the fastest mile being run at the rate of 76 miles an hour.

In 1891 North America had 187,425 miles of railway, or about $21\frac{1}{2}$ miles to every 10,000 inhabitants. Europe had 141,000 miles, or four miles to 10,000; Asia, 20,000 miles or only $\frac{1}{4}$ mile to 10,000,; South America, 16,000 miles, or five miles to 10,000; Australia, 13,000 miles, or nearly $3\frac{1}{2}$ miles to 10,000; and Africa, 6000 miles or $\frac{8}{10}$ of a mile to 10,000 inhabitants. North America has therefore nearly as many miles of railway as all the rest of the world put together. The longest railway is the Canadian Pacific, from Montreal to Port Moody on the Pacific, 2893 miles; but the Russian Siberian railway, from St. Petersburg to Vladivostok on the Japan Sea, will be when finished more than 5000 miles long. A railroad through Central America, connecting the railways of the United States and Mexico with the South American railways, is to be built. It is called the Pan-American, because it is to connect all the American republics.

Underground Railroads. The first underground railroad was opened in 1863 in London; several others have been built since, and there are now more than twenty miles in operation. The first ones were in tunnels near the surface, with frequent cuttings open to the air. Steam engines were used, and the roads were very uncomfortable from gas and bad smells. A new system of

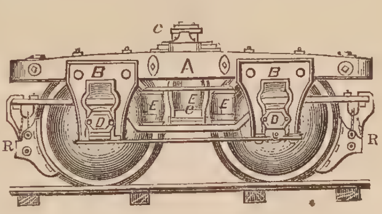


Fig. 7.—American Railroad Truck.

underground railways, called the Greathead system, in which the cars run in a very deep tunnel, sometimes 40 to 50 feet below the surface, has lately been tried with success. The tunnels, of which there are two side by side for trains in each direc-

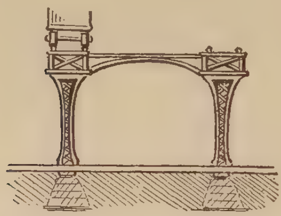


Fig. 8.—Elevated Railroad, Ninth Avenue, End View.

tion, are cut through earth and rock below the foundations of the buildings, and, as fast as made, are lined with great iron tubes which are packed closely outside with broken stone and cement. The cars, which very nearly fill the tunnel, are run by electric power, so that there are no cinders nor gases, and the air is always sweet and pure. Passengers are carried between the street and the stations by elevators. Other roads on the Greathead system are to be built, and it is probable that London will soon be as noted for underground railways as New York is for elevated roads.

Elevated Railroads. The first elevated railroad was built in 1872 by the New York Elevated Railroad Company on Ninth Avenue, New York. In 1878 the Metropolitan Elevated Railroad Company opened railways on Sixth and Ninth Avenues, and the first train was run to 155th Street, December 1, 1879. The Second Avenue line was completed in 1880. In 1884 the Manhattan Railway Company, a company organized in 1875, but which built no roads, leased all the elevated roads, and they have since been operated under its name. More than two hundred million passengers are carried yearly by these roads.

Elevated railroads are simply rail-

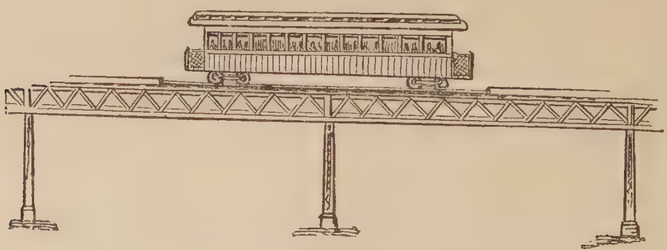


Fig. 9.—Elevated Railroad, Sixth Avenue, Side View.

roads on iron bridges raised above the street. They are constructed on two general plans, in one of which the tracks are supported on posts directly under them, as in Fig. 8, and in the other both tracks are between the posts, as in Fig. 9. The first plan is that used on the Ninth and Third Avenue roads; the second that of the Sixth Avenue road. The rails are laid between heavy guard timbers, so that it is almost impossible for the cars to get off the track. A large picture of the elevated railway and a station is given in C. P. P. in the article NEW YORK.

Several elevated railways have been built in Brooklyn, and two lines were begun in Chicago in 1890. The Stadtbahn or City Railway in Berlin is an elevated road seven miles long, on brick and stone viaducts, with iron bridges at street crossings, running across the city from east to

west, connecting the Ringbahn or Ring Railway, which runs around the city. An elevated railway with double tracks is building around Vienna; and one, called the Overhead Railway, 5¾ miles long, was opened in Liverpool in 1892.

Horse Railroads. The street railway, with cars drawn by horses, so common in the United States, is called in England a tramway. In this country these roads are always fitted with iron rails, but in some places wooden rails are used, and in several Italian cities the cars run on granite slabs, about two feet wide, laid with close joints. In 1891 there were 5443 miles of horse railroads in the United States, but it is probable that most of them will soon give way to the cable or the electric railway. On New York lines horses are driven 6 to 6½ miles an hour, and each horse has to travel 16 to 17 miles a day.

Cable Road, a railroad of which the motive power is an endless wire rope or cable running through an iron tube underground, and kept in constant motion by stationary steam engines. The cars are attached to the rope by means of a gripping attachment which passes through a slot in the upper side of the tube. This system was invented by A. S. Hallidie of San Francisco, and first applied on the Clay Street Hill Railroad, San Francisco, in 1873, which was discontinued in 1891. The road was so successful that others were soon built in San Francisco, Chicago, Kansas City, Denver, and other western cities, and in 1891–92 two horse railroads in New York, the Broadway, and the Third Avenue lines, were changed to cable roads. The cars on the Brooklyn Bridge also are moved by a cable. The first cable railroad out of the United States was built in 1882 in New Zealand, to connect Dunedin with its suburb of Roslyn. In 1884 the Highgate Hill road was built in London, and others soon after in Edinburgh and Birmingham. In 1891 a system of cable roads 85 miles long, said to be one of the most perfect in the world, was completed at Melbourne, Australia. In 1892 more than 700 miles of cable roads were in operation in the United States. In crowded streets cable roads can run about eight miles an hour; in suburban places, about fourteen miles.

Electric Railroad. The first successful electric railway was built in Berlin by Dr. Warner Siemens, for the Industrial Exhibition of 1879. The rails, which were laid in a circle about a third of a mile long, had between them a third rail by which the electric current was carried to the motor (see ELECTRICITY) in the front car of the three that made up the train.

In a building at the end of the line was a steam engine which drove a dynamo, and a wire from this carried the electricity to the third rail. When the train was ready to start, the turning of a handle pushed down upon this third rail from the bottom of the first car a brush of copper wires, by means of which the electricity was carried to the electromotor, and the electrical power being changed in it to mechanical power, the axle of the driving wheels was turned. Much of the electricity thus used to drive the motor was saved, for, the driving wheels being insulated, the electricity passed from them to the two outer rails and thence back to the dynamo.

The first electric railway in America was built by Thomas A. Edison at Menlo Park, N. J., in 1880. In 1883, Stephen D. Field of San Francisco exhibited his electric railway in Chicago. In both of these the electricity was carried to the motor by means of the rails.

The trolley or overhead system, invented by Dr. Joseph R. Finney of Pittsburg, works in a somewhat different way. The electricity, instead of being supplied through the rails, is carried from the dynamo, in

the station marked D (Fig. 10), by means of a wire W, to the insulated copper wire, about as thick as a lead pencil, L, suspended on posts along the line of the railway about fifteen feet above the track. Along this slides a little pulley, called a trolley, T, connected with the motor in the car by a wire or rod, R, through which the electricity is carried to it. The current then passes into the wheels of the car and thence into the rails, through which it is returned to the dynamo. This is the principal kind of electric car system now used in the United States, where it is employed by several hundred street railways. There are many different ways of using the trolley, bearing the names of their inventors, such as the Edison-Sprague, the Thomson-Houston, the Short, the Rae, and the Westinghouse systems. The most common way now is to have the trolley wheel on the end of a long arm, connected with the top of the car, by which it is pushed up against the wire underneath.

Another method, called the underground system, consists in having the wire which supplies the electric current in a conduit underground instead of on poles overhead. This is really the same in principle as the overhead system, but is safer and therefore better adapted for cities, where both men and horses have been killed by the electricity in falling wires. It is, however, much more costly than the trolley system, and is not much used.

Still another way of driving electric cars is by means of a storage-battery, in which enough electricity can be stored in the car itself to carry it a certain distance, when it has to get a fresh supply from a dynamo. A car fitted with a storage battery was first run at the Paris Exposition of 1881. Since then various methods, such as the Julien, the Daft, the Main, the Patton, and the Edco system, have been tried with varying success. Julien cars have been run on the Fourth Avenue line in New York and also in Philadelphia, Indianapolis, and other cities, but the system is more costly than the trolley system, and has not yet come into general use. Motors worked by storage batteries are used also to drive carriages and tricycles on land and canoes and launches on water. It is probable that the electric motor will in a few years take the place of horses on street railway lines, and even supersede the steam locomotive. This will do away with smoke and sparks and much of the noise of railway travel, for, as the motor may be placed under the cars, no locomotive or tender will be needed. The speed, too, of railways will be greatly increased, and may reach even a hundred miles an hour. In 1891 more than 3000 miles of electric railways were in operation in the United States.

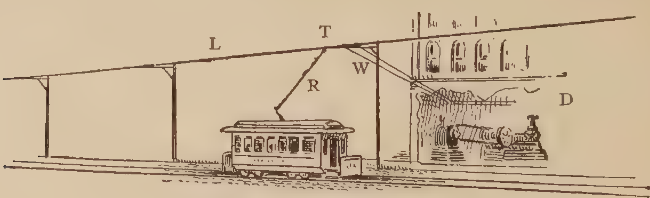


Fig. 10.—Electric Railroad, Trolley System.

Mountain Railways. The inventor of the mountain railway was Sylvester Marsh of New Hampshire, who built the first one up Mt. Washington, in the White Mountains, in 1868–69. Besides the two ordinary rails on which the cars run, there is a middle double rail fitted with cross-

pieces forming a kind of rack into which a cog wheel on the locomotive fits, so as to keep it from slipping. In 1872 a similar road was built up Mt. Righi, on Lake Luzerne, in Switzerland. In 1880 a cable road was finished up Mt. Vesuvius. The road up Mt. Pilatus, on Lake Luzerne, opened in 1889, is on the Abt system, which permits the locomotive to run on ordinary rails until it reaches a steep place and then change at once to the rack system. This saves much of the cost of railway building, as elevations may be crossed instead of being tunnelled under or cut through. The Pilatus road worked so successfully that many others like it have been built in Germany, France, Switzerland, in South America over the Andes, and in the United States up Pike's Peak. The last, opened in 1891, is 8¾ miles long. It runs from Manitou, Colorado, 6600 feet above the sea, to the summit, 14,200 feet high. Plans are now made for roads up Mont Blanc and the Jungfrau, and in Scotland up Ben Nevis and Snowdon.

Ship Railway. A railway to carry ships and other vessels across isthmuses instead of cutting a canal has often been proposed, especially across the isthmus of Panama and at Tehuantepec, Mexico, but the first one begun to be built (1888) was the Chignecto ship railway across the isthmus of that name connecting Nova Scotia with Canada and separating the Bay of Fundy from the Gulf of St. Lawrence. The railway is to be a double track 17 miles long and perfectly straight. Two locomotives, one on each track, will move with ease the largest vessel carried across. At each end is to be a basin closing with a gate, into which the vessel will be floated into a cradle with wheels, which will then be raised by hydraulic presses until high enough to run on to the railway track. The vessel will be let down in the same way at the other end into another basin and then floated out ready to proceed on her voyage. From 300 to 700 miles will be thus saved, but the railway is not yet (1893) finished.

RAIN. There is always a large amount of watery vapor in the AIR. While this is kept warm enough it remains there, but if the heat falls below the DEW point, the vapor will be condensed or turned to water, and will change, according to circumstances, to dew, rain, SNOW, or HAIL. If the vapor be condensed near the surface of the earth, it turns to dew, but if the condensation takes place high up in the air, the particles of vapor begin to fall of their own weight, and, uniting with others as they come down, form drops of rain. When the rain cloud is near the earth it is usually full of water, and the raindrops are much larger than those which fall from a higher cloud.

Rain purifies the air by washing it, by mixing the air of the upper regions with that of the lower regions, and by cleansing the earth so that bad gases are not so apt to rise from it. Rain is usually pure, but takes up from the air as it falls a little CARBONIC ACID and AMMONIA; and it is this which makes it better for plants than pump water. In some parts of the world little or no rain falls, and those places are consequently dry and treeless; in other places it rains almost every day. More rain falls in mountainous than in level countries, because the currents of air, warmed by blowing over the earth, strike against the sides of the mountains, and are thus turned upward into the cooler air of the higher regions, where they are condensed and fall as rain.

In some countries where droughts are common, people have various ways of asking for rain; and some think they can make rain. In Northern India a fakir will sometimes have himself hung up by the heels naked, his body smeared with cowdung and ashes, and swung back-

ward and forward by ropes. If it happens to rain while he is undergoing this penance, he takes all the credit of it to himself.

It has often been noticed that a heavy cannonading has been followed by a fall of rain, and in 1880 a patent for making rain by firing explosives in the air was granted to Daniel Ruggles of Fredericksburg, Virginia. In 1891 experiments were made in Texas, under the superintendence of Gen. Dryenforth, by sending up kites carrying dynamite, which was exploded in the air, but the results were not very satisfactory.

The word rain is from the Anglo-Saxon *regn* or *ren*, rain, from the Latin *rigare*, to wet.

RAINBOW. In the article LIGHT is told how white light is made up of seven different colors, and how these colors may be separated by causing a beam of light to shine through a prism. These same seven colors are seen in the rainbow, put together in the same order, namely, violet, indigo, blue, green, yellow, orange, red, and they are made in the same way, only that the rays of light shine through raindrops instead of through a prism. The white light is thus separated into the colors out of which it is made, and these colors are so reflected from the round raindrops that they are made to form a circle. We can generally see only half the circle, or a little less than half; but if we were on the top of a high mountain we could see much more. Sometimes rainbows are made by the sun's rays falling on the spray rising from waterfalls, and then the whole circle can usually be seen.

The rainbow can be seen only when the sun shines during a fall of rain and when the sun is in one side of the heavens and the rain in the other, so that we can stand with our back to the sun and look at the rain. If the sun and the rain are in the same direction from us, no rainbow can be seen. Most rainbows are seen in the afternoon, when the sun is in the west, and rain clouds come from the west and clear up by passing off to the east, but sometimes one is seen in the morning. Rainbows are never seen in the middle of the day, because the sun is then above us and we cannot stand between it and the rain. Sometimes two rainbows are seen at once, one outside of the other one. The inner or primary (Latin *primus*, first) bow, as it is called, is always the brighter, and the red band of color is always on the outside; the outer or secondary (Latin *secundus*, second) bow is much fainter in color, and the red band is always on the inside. This is because in the primary bow the sun's rays are only reflected once, while in the secondary bow they are reflected twice, which makes them fainter in color, and turns them upside down. Rainbows are sometimes formed at night by the moonlight; but they are not so bright as those seen in the daytime.

The word rainbow is from the Anglo-Saxon *renboga*, from *ren*, rain, and *beogan*, to bend.

RAISIN, the dried fruit of the European grape-vine. Raisins are dried in two ways: in one the stalk of each bunch of grapes is cut nearly in two, and the grapes are then left to dry on the vines; in the other, the bunches are wholly cut off and hung up or laid on floors to dry. The first kind are the best, and are called Muscatel raisins, or raisins of the sun. The finest come from Malaga and Valentia in Spain. The second kind are called Lexias. When dried the raisins are dipped in hot lye, made from wood ASHES, in which is mixed a little olive oil and salt, afterward dried again in the sun, and then packed in boxes for sale. Large quantities of raisins are now made in California, especially in Fresno County, from the fruit of grape vines originally brought from Spain. The bunches of grapes are placed in trays when cut and left in

the open air from one to three weeks, according to the amount of sunshine, to cure. They are then sorted and put into the sweat-boxes, each of which holds 125 pounds. The boxes are piled up in a brick building without windows and left to sweat for ten to twenty days. This softens the stems and makes all equally moist. They next go to the packing room, where they are sorted into first, second, and third grades. The two higher grades are packed in boxes; the third grades are packed in sacks and sold as loose raisins.

Sultana Raisins are made from a kind of grape which has no seeds. They are sometimes called Smyrna raisins, because they are brought from Smyrna in Asia Minor.

Zante Currants are another kind of raisins made from small grapes about as large as peas, which grow in the island of Zante and in other Greek islands. Great numbers of these grapes are raised there, and there is a large trade in the dried fruit. In old times these grapes were called corinths, because many grew near Corinth. In some old books they are called "currans," and some think that out of this grew our word CURRANT.

The word raisin is from the French *raisin*, grape.

RASPBERRY. The wild bush or shrub on which the raspberry grows is rightly named the bramble, and it belongs to the same family with the BLACKBERRY. Several kinds of raspberries grow wild in the United States, the best of which are the red, found in the Northern and Middle States, and the black, called sometimes blackcap and thimbleberry, which is common as far south as Georgia. The cultivated red raspberry was brought to this country from Europe. Raspberries are used for dessert, for jams, jellies, and sweetmeats, and are made into a kind of wine, from which a strong spirit can be distilled (see ALCOHOL).

The raspberry is not a real berry, but a collection of stone FRUITS.

The word raspberry is made up of rasp and berry; some think it is called rasp from the roughness of the fruit, and others think that it is from the Italian *raspo*, a bunch or cluster of berries; berry is from the Anglo-Saxon *berie*.

RAT. There are two kinds of house rats in the United States, the black rat, and the brown or Norway rat, as it is sometimes wrongly called. Both came first from Central Asia into Europe, and were brought thence to America in ships; the first about the middle of the sixteenth century, and the second about the beginning of the Revolutionary War. The black rat is smaller than the brown, and rather cleaner in its habits, preferring the upper parts of houses to the cellars, sewers, and other damp and dirty places where the brown rat lives. The two kinds do not like each other, and the brown rat, which is the stronger of the two, has waged such fierce war against the black one as to drive it almost entirely away from many places.

Rats increase very fast, having young three to five times a year, and ten to fifteen at a birth. If means were not taken to destroy them they would soon overrun the country; but they are hunted by men, dogs, weasels, and cats, and they themselves kill and eat the young and weak of their own race.

Rats do much damage in houses and often injure the farmers' crops, but they are very useful in eating both animal and vegetable substances which if left to decay would make sickness. Their teeth are sharp and strong, so that they can easily gnaw wood, and even bone and ivory. Their senses are sharp, and they are very cunning animals. They often use their tails to get food out of bottles or other vessels too narrow to get their heads in. A lady once found that her jelly

jars, which were kept on a shelf in the cellar, had been robbed, though they were covered tightly with pieces of bladder. On looking at them more carefully she saw that a little round hole had been gnawed through the covering of each jar, and that the jelly had been lowered just about the length of a rat's tail. She afterward found out that the rats had gnawed through the bladder and drawn the jelly out little by little by running their tails down through the holes.

A lady in New York once tried to poison the rats in her house by putting near their holes pieces of meat spread over with PHOSPHORUS paste; but, strange to say, though the meat was carried off every day, the rats seemed to grow more numerous all the while. After watching a long time, she at last found out the reason. In an alley next to the house was a hydrant, from which, the end being broken off, the water was running all the time. Under this she found several pieces of the meat, and she saw some of the rats carry the poisoned meat from the back door of the house into the alley and put it under the running stream of water. After it was washed they would eat it.

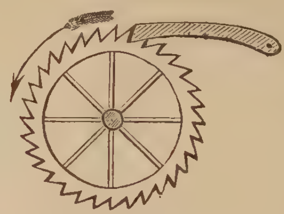
The flesh of rats is eaten by the Chinese and some other Asiatic peoples, and by some African tribes, and their skins are made into a fine kind of leather for gloves. There are men who make a business of catching rats for their skins.

The rat is a MAMMAL of the order *rodentia*, or gnawing animals, and of the same family with the mouse.

The word rat is from the Anglo-Saxon *ræt*, rat.

RATCHET, a small piece of metal hung on a pivot at one end so that the other end can fall of its own weight into the teeth of a wheel, as shown in the picture. It is also called a pawl or click. As will be seen, the wheel can move only the way the arrow points, as the ratchet prevents its turning backward. Such a wheel is called a ratchet wheel.

The word ratchet is in French *rochet;* in Italian, *rocchetto* means the cog-wheel of a mill.



Ratchet Wheel and Ratchet.

RATTAN, a kind of palm tree, which grows in the East Indies. Some rattan palms are low bushes, some are very tall trees, and some have a reed-like, slender stem, seldom more than an inch thick, which climbs like a vine over the tops of trees, sometimes for several hundred feet. These long stems are much used for making ships' cables, cables for suspension bridges, and other kinds of ropes. Great quantities of them are sent to Europe and the United States, where they are made into various kinds of plaited and wicker work; and many articles of furniture, ladies' work baskets, and other things are manufactured from them. Malacca canes are made from a kind of rattan palm.

The word rattan is from *rotan*, the Malay name of the tree.

RAVEN, a bird of the crow family, but larger than the common crow, being sometimes 25 inches long with a spread of wing of 50 inches. Its plumage is glossy black, as well as its bill and feet. The raven is seldom seen now east of the Mississippi, but is abundant in the West, wherever the crow is not found. It feeds on small animals, eggs and young birds, carrion, mollusks, crustaceans, insects, nuts, and berries. Ravens are found in Europe, Asia, and Africa. It is said to be very long

lived, and some are reported to have reached the age of a hundred. The ancients considered it a bird of ill-omen, and in modern times it has been looked on with superstition on account of its color and its hoarse, mournful croak.

The raven belongs to the order *insessores*, or perching birds.

The word raven is from the Anglo-Saxon *hræfn*, raven.

REDFISH. This fish, caught from Chesapeake Bay to the Gulf of Mexico, has many names. In the Chesapeake it is called Red Drum, in the Carolinas and southward Red Bass and Sea Bass. In Florida Red Fish and Red Horse, in Louisiana, by the creoles, Poisson Rouge, (French for Redfish), and in Mexico Pez Colorado (Spanish for Redfish). It grows from one to four or five feet long and averages about ten pounds in weight, though it sometimes reaches forty pounds. In the Gulf of Mexico it is red, but on the coast above Florida it scales are silvery tinged with red. Redfish, which are caught with gill nets, are much esteemed for food at the South. They are often to be seen in New York markets.

The **Red Fish** of California, a different kind of fish, is sometimes called Sheepshead and Fathead from its fat forehead. It weighs twelve to fifteen pounds. It is very plentiful on the Pacific coast, and is caught in great numbers by the Chinese, who salt and dry it, but its flesh is coarse.

REDWOOD, a large kind of tree which grows in California from the boundary of Mexico northward, never very far from the coast. There are great forests of it on the Coast Range of mountains, and it is largely cut for lumber where it can be got out easily. The trees grow sometimes 300 feet high and are often 16 feet in diameter. The wood, which looks like red cedar but darker, is light and close-grained and is much prized for furniture and cabinet work. It is very durable, too, and is not attacked by insects. In cutting down these great trees saws are much used instead of axes. The trunks are afterward cut up into logs and transported on a railway to the mill to be made into lumber. It is a curious sight to see twenty or more cars on a logging railway, each loaded with a single log as long as the car and as high as it is long, all drawn by a single locomotive. There is a grove of redwood trees also in Pierce County, Washington, some of which are nearly 400 feet high.

REED BIRD. See BOBOLINK.

REINDEER. In the article DEER is told about the caribou, or American reindeer, which is believed to be only a kind of the reindéer of the Old World; but the name reindeer is generally given only to those in the cold northern parts of Europe and Asia, where they are used as beasts of burden and draught. The reindeer of Lapland is about four and a half feet high at the shoulder, or as large as the red deer of England, but its body is heavier. Its legs are well formed and strong, and its feet are broad and well fitted to travel on the ice and frozen snow. Its hair is rough and thick, and is brownish yellow in winter, but in summer is grayish white. The head is wide and much like that of the ox, and both the males and females have horns, which are shed every year.

The reindeer is very valuable to the Laplander, who could not live in his cold icy country without it. It is at once his horse, his cow, and his sheep; for he drives it in harness, milks it, and makes cloth of its hair. Its milk is said to be better than that of the cow, and from it excellent butter and cheese are made. Its flesh is very sweet and wholesome, but generally the animal is too valuable to kill. Its hair is easily spun and woven into cloth, and its skin makes fine leather. From its horns are made knife handles, spoons, and many other

things, and its dried dung is used for fuel.

The harness of the reindeer is very simple. A skin collar is fastened around its neck, and from this a single trace passes down between the legs and under the belly, and is fastened in a hole in the front of the sled. The driver uses but one rein, which is tied to the bottom part of the animal's horn, and drops it on the right or the left side of the back as he wants to go one way or the other. The sled, called a *pulka*, is like a canoe, and has no runners, but sits flat on the ground. It is very light and will turn over easily; but the Laplander is so skilful that he rides over the steepest and most slippery places with ease and safety. Harnessed in this way, the reindeer can travel very fast. On level ground it can go as many as twenty miles an hour; but its common gait is from twelve to fifteen miles an hour. In Sweden once a reindeer carried an officer with important dispatches eight hundred miles in forty-eight hours, but the poor animal died after it. The picture of this reindeer is shown in one of the palaces.

The poorest Laplander keeps several reindeer, and many keep hundreds and some even thousands in a great herd. They are driven out in the daytime to feed on the LICHENS, which they root up with their noses from under the snow, and are kept at night in sheds or in places surrounded by high fences to protect them from wild beasts. The herds have to be watched carefully, as the reindeer is apt to run away and join wild reindeer in the mountains. Each one is branded, that is, has burned on it with a hot iron the mark of its owner, so that it may be known if it strays or gets mixed with others.

The reindeer in Siberia are larger than those in Lapland, and are used not only to draw sledges, but also under the saddle. They are very hard to ride, for the skin on the shoulders is so loose that the saddle moves from side to side. When it tips to the left the rider has to lean to the right, and when to the right he must lean to the left, or he will be apt to lose his balance and fall off. The sledge used in Siberia is different from that in Lapland, having high runners, and the reindeer are usually driven in pairs instead of singly. In 1891 some reindeer were taken from Siberia to Alaska, in hope of introducing the animal into that country.

The reindeer is a MAMMAL of the order ruminantia, or cud-chewing animals.

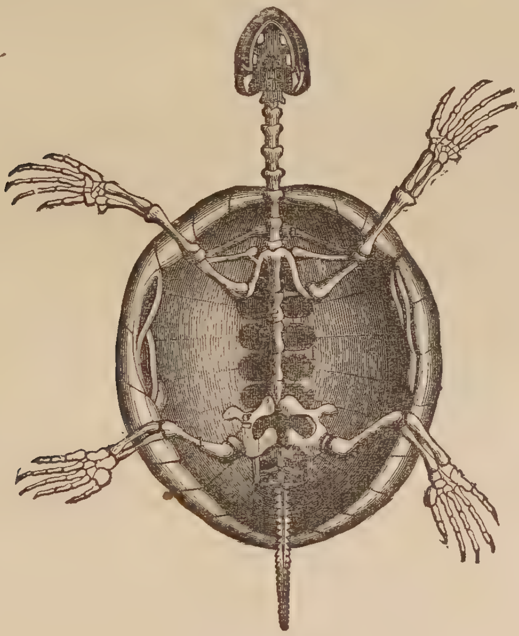
The word reindeer is from the Anglo-Saxon *hrandeór*, reindeer.

REPTILE. Like other vertebrate ANIMALS, reptiles have a backbone with a spinal marrow running through it, but the other parts of the skeleton are much more varied than in mammals, birds, and fishes. The snakes have only a skull, a backbone, and ribs, while in the turtles and tortoises the breast-bone is spread out to form the under shell and the ribs are made into the upper shell. In the picture the under shell of the turtle is taken off so that the whole skeleton can be seen. The chain of bones making up the backbone reaches from the head to the end of the tail. Like mammals and birds, reptiles breath air through lungs, but like fishes they are cold blooded, and therefore do not feel common changes in heat or cold. For the same reason they are slower in their motions than warm-blooded animals, and cannot keep up their movements so long; but their life is not so easily destroyed, and they will bear more bruising and maiming.

Excepting the turtles and tortoises, reptiles are generally long, the body being round and ending in a long tail. The serpents are without feet, but almost all others of this class have four limbs. The outer covering of the body varies; some of the lizards have regular scales like fishes; others and the serpents have

small scales on the true skin, which are covered with another skin; while the crocodiles and turtles have hard bony plates. The senses of reptiles are duller than those of mammals and of birds, but not so dull as those of fishes. They are almost all flesh-eaters. The tortoises and crocodiles bite up their food, but the snakes swallow theirs whole. All reptiles are oviparous (Latin *oviparus*, from *ovum*, egg, and *parere*, to bring forth, that is, their young are hatched from eggs laid by the parent. But they are not usually hatched by the heat of the body, like those of birds, but are laid in warm sandy places, where they are open to the rays of the sun, or on heaps of vegetable matter which in rotting furnish heat enough to hatch them.

Most of the reptiles live in warm countries, in which also the largest kinds are found. In cold countries many of them hibernate (Latin *hibernare*, from *hiems*, winter), that is, they pass the winter in a torpid or sluggish state, sleeping most of the time.



Skeleton of Turtle.

Reptiles are divided into four orders, as follows.

I. CROCODILES, including the crocodiles of Africa and of Asia, and the ALLIGATORS of America. Crocodiles usually live in the rivers of warm countries. They are among the largest of living reptiles, and are covered with a rough, hard, scaly coat, which forms the epidermis or outer SKIN. The skull is long, and they have only one row of sharp teeth. Their feet are webbed, and fitted with strong claws. The crocodiles come nearer to the birds in the way they are made than any other reptiles, having, among other like

things, a stomach much like a gizzard, and a skin which can be drawn over the eye.

II. TURTLES, including tortoises.

III. SNAKES.

IV. LIZARDS.

Reptiles belong to the third class of vertebrate ANIMALS.

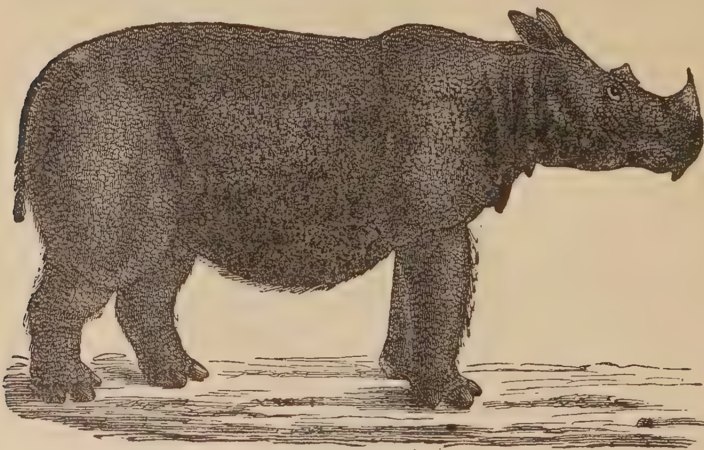
The word reptile is in Latin *reptilis*, which comes from *repere*, to crawl or creep.

RESINS, a class of substances obtained from plants, and which are very useful in the arts. They are made up of CARBON, HYDROGEN, and OXYGEN, and are probably the essential OILS of the plants oxidized, or hardened by the oxygen of the air. They will dissolve in alcohol, ether, and other things, but not in water like the gums. Among the hard resins are copal, lac, mastic, benzoin, etc.; and among the soft resins, turpentine, storax, and copaiva. Common resin is told about under TURPENTINE.

The word resin is from the Latin *resina*, resin.

REVOLVER. See PISTOL.

RHEA. See OSTRICH.



The Indian Rhinoceros.

RHINOCEROS. This animal is found only in the warm parts of Asia and Africa, though in very ancient times it lived in Europe and in America, where its bones have been found in Texas, Nebraska, California, and other parts of the West. Excepting the elephant, and perhaps the hippopotamus, it is the largest of land animals. It is about twelve feet long and six feet high, when full grown, and has a large body and short legs, a long ugly neck and head, with sometimes one and sometimes two horns rising up from the end of the nose, and small cunning eyes set very low down. The skin, which is without hair, is very rough and hard, and so thick and tough that the lion and tiger cannot scratch through it; it will turn the edge of a sword and resist a common musket ball. The rhinoceros lives in forests, and feeds on herbage and twigs and shrubs. After the heat of the day it generally goes to some water-hole to quench its thirst, and often wades in and wallows in the soft mud, leaving nothing but its head out of water. As no other animal can hurt it, it knows no fear, and will drink close beside a troop

of lions without appearing to notice them. It is often followed by a flock of birds called rhinoceros-birds, because they sit on its back and pick off the insects from its skin. On the approach of danger the birds warn the rhinoceros by their cries, and so enable it to escape. Sometimes they even awake it when asleep.

The **Indian Rhinoceros** has but one horn. It has been known from ancient times, and is supposed to be the unicorn mentioned in the Bible. It is the kind usually seen in menageries, where it is sometimes taught a few tricks, though it is not so intelligent as the elephant.

The **Black African Rhinoceros** has, like all other African rhinoceroses, two horns, though the hind one is only about a third as long as the front one, which is generally eighteen inches. This is the most savage of the rhinoceroses and is considered by hunters the most dangerous of all African game.

The **African Keitloa,** which is also black, surpasses it in size, and has two horns of nearly equal length.

Head of Keitloa.

It is savage when aroused, but not so dangerous as the black one.

The **White Rhinoceros,** the largest of the African kinds, is a pale brownish white, with reddish purple tints on the shoulders. It is rare, is rather timid, and is much prized by the nations for its flesh, which is fat and juicy. It lives almost wholly on grass.

The rhinoceros is a MAMMAL of the order *pachydermata* or thick-skinned animals.

The word rhinoceros means nose-horn. It is from the Greek *rin*, nose, and *keras*, horn.

RHUBARB, the dried root of a plant which grows in Central Asia. The best rhubarb formerly came from Turkey and Russia, but now the most of that used in the United States is brought directly from China. It is used as a medicine, especially in cases of diarrhœa, and is given to children who have eaten things which do not agree with them.

Pie-plant. The rhubarb of our gardens, commonly called pie-plant, was brought to Western Europe from the banks of the Volga, about three hundred years ago. Its leaves were first used for greens, as we now use spinach, but only the stalks are now eaten, either as a kind of preserve or made into pies. It is very wholesome in early summer, as it contains the same kind of acid as the apple, together with a little potash, which makes it a good blood purifier.

The word rhubarb is from the Greek *Rha*, the ancient name of the river Volga, on whose banks it grew, and *barbara*, foreign.

RIBBON. Ribbons are made chiefly at St. Etienne in France, Basel in Switzerland, Coventry in England, and Crefeld in Prussia. The French and the Swiss ribbons are mostly made by hand, and are the best in the world. English ribbons are made by machinery, and are not considered so good as those made in France. The best ribbons are made of Italian and French silk, but cheaper kinds are made of inferior silk, and in some much cotton is used. Galloons are made largely of cotton, and some ribbons are now made entirely of it, and afterward printed in colors. Fine ribbons are now made in Paterson, New Jersey.

The word ribbon, Old English *riban*, French *ruban*, at first meant

a red ribbon, and is from the Latin *ruber*, red.

RICE. This grain first grew in Southern Asia, probably in China. It spread from there to India and to the valley of the Euphrates, and later into Egypt, though there are no pictures of it on the monuments and no grains have been found in mummies. The Arabs carried it to Spain, whence it went to Italy. It now grows in all the warm parts of Asia, Africa, and America. It is cultivated chiefly in China, Japan, Madagascar, the East and West Indies, the south of Europe, and in the United States and Central America. The best in the world grows in the United States, in North and South Carolina. It is said that the seed came from Madagascar. The rice plant is a kind of grass which thrives best in low damp land, as it needs a great deal of water. After the seed has been sown the field is usually flooded with water several inches deep until the seeds sprout. The water is then drawn off, but the field is again flooded before the grain ripens, and the higher the water rises the higher the rice grows, the ear always keeping above the water. It commonly grows three or four feet high, and bears its grain in heads, much like oats.

A few days before the rice is ready to cut, the water is drawn off from the field and the grain is cut with sickles and spread out to dry. The next day it is tied up in sheaves or bundles, carried on to dry ground, and piled up in stacks. The rice is separated from the straw in a threshing machine, from which it comes out with the husk on. The husk is taken off in a mill, where the rice passes between large grinding stones, which rub it off and leave the grains white and clear. As many of the grains are broken in this grinding, the rice is then turned round and round in a barrel made of wire netting, the meshes of which grow larger toward the bottom. In this way it is divided into several kinds: first the flour falls through the fine netting at the top, then the small pieces through the next larger holes, then the "middling" rice or large pieces pass through, and lastly the whole grains fall out at the end.

Rice is the principal food of nearly a third of the human race, mostly in hot climates, such as Southern China, India, Burmah, and Siam, yet it is not so good for food as wheat and some other grains. More than nine-tenths of rice is made up of STARCH and water, and only about a third of the other tenth is GLUTEN; so that it makes, when eaten, more fat than muscle. New rice is not so good for food as old rice, as it is less digestible. It ought not to be eaten until at least six months old, and in India some say that rice three years old is the best. The Japanese make a kind of beer, called *saki*, and the Chinese several kinds of wine out of rice, and the *arrack* of the East Indies is distilled (see ALCOHOL) from it. Starch for laundries and muslin manufactories is made largely from rice: the straw is plaited for hats, and the waste part furnishes food for cattle.

Rice Glue or Japanese cement is made by mixing rice flour with cold water, and then boiling it until it is thick. When made very thick, it may be pressed in moulds and made into models, busts, and other things.

Rice Paper, used by the Chinese for painting flowers, insects, and other small things on, is not made from rice, but is the inner bark of a kind of tree.

The word rice is from the Latin *oryza*, Greek *oruza*, which probably came from the East Indian (Tamil) *arisi*, rice.

RICE BIRD. See BOBOLINK.

RIFLE. The first firearms for hand use were simply long tubes without any lock, which were fired by putting a live coal or a lighted slow-match to the touch-hole. These tubes sometimes had a long straight handle which was held under the

arm when the piece was fired, but they were commonly laid on a wooden frame or on a wall.

The **Match-lock** gun, which came into use about the end of the fourteenth century, was fitted with a kind of lock in which the burning match was brought down to the powder in the little pan beside the touch-hole by pulling the trigger. This was a clumsy way of firing a gun. Each soldier had to carry several yards of slow-match, which was a kind of soft rope or cord so made that it would burn very slowly. Its fire was apt to be put out by the rain, and when the wind blew the powder was often blown out of the pan so that the gun would not go off.

The **Wheel-lock** gun, first made in Nuremberg in 1517, had a toothed wheel which turned round quickly when the trigger was pulled and struck fire on a flint, the sparks from which kindled the powder in the pan. This gun was better than the match-lock, because the pan had an iron cover which opened when the lock struck the flint, and so the wind and rain did not hinder it from being fired. But it could not be fired very fast because the lock had to be wound up with a key like a clock before being used. Before this time the gun had been generally called arquebus or harquebus, but the wheel-lock gun was given the name of *mousquet*, from *mouchet*, a sparrow-hawk.

The **Flint-lock** gun came into use in the seventeenth century. In this the flint was made to strike fire by causing it to fall against the top of the powder pan. This forced the top of the pan open, and the sparks thus fell into the pan and on the powder. In 1671 the French began to use this gun, which they called *fusil*, from the Italian word *focile*, a flint. In 1686 the English armed three regiments (the 7th, 21st, and 23d) with fusils, from which they were given the name of Royal Fusileers, which they still bear. The English did not begin to call these guns muskets until 1738.

The **Percussion-lock** musket was first made in the beginning of the present century, but it did not come into general use until after 1840, up to which time the flint-lock musket was used in all the armies of the world. The percussion-lock musket has fitted to the side of the barrel a little tube, called the nipple, which opens into the barrel at its back end. This tube is just large enough to hold a percussion cap, a little cap made of thin sheet copper, covered on the bottom of the inside with percussion powder, a kind of powder which explodes when struck. The lock is so made that when the trigger is pulled, a part called the hammer is brought down by a strong spring on to the cap. This fires the percussion powder, and the fire from it is forced through the nipple into the powder of the barrel. This kind of gun was generally used in all armies until rifles made to be loaded at the breech with brass cartridges were introduced.

Rifle. The old kinds of guns had smooth bores, that is, the inside of their barrels were bored out smooth. These would not shoot a ball very far nor very straight, and in time it was found out that guns could be made to shoot truer and further if little channels or grooves were cut on the inside of the barrels. Guns whose bores are cut with these grooves are called rifles. The grooves, which differ in different kinds of rifles in shape, size, and number, do not run straight from one end of the barrel to the other, but are made with a twist, so that they usually turn round the barrel once in its length. When the gun is fired the ball has to follow the grooves in passing out of the barrel, and this gives it a twist which makes it turn round very fast after coming out of the barrel, and always in the same way. In the smooth-bore gun the

round bullet used in it would also turn round sometimes; but the motion was not always the same, and this was apt to throw it out of its right line of flight; but the rifle ball, being made to turn exactly in the same way all the time, goes much truer and straighter. As it is commonly made pointed like a cone, it also cuts through the air easier, and therefore goes much farther.

Both small arms and cannon are now grooved, or rifled as it is called, and both kinds are alike called rifles, the different kinds of each being known generally by the names of their inventors or those who first made them; but cannon were not called rifles before the present century. The rifling of small arms has been done for more than three hundred years, but rifles did not take the place of muskets in war until late years.

Breech-loaders. Both cannon and small arms were made to load at the breech, that is, at the back end, several hundred years ago, but they were not very well made, and did not come into general use. During the past twenty-five years great improvements have been made in them, and now every principal nation in the world uses some kind of a breech-loading rifle.

The old-fashioned musket was loaded at the muzzle, that is, at the mouth. This took much time, and though soldiers were taught to load quickly, not more than two shots could be fired in a minute, while with some breech-loaders fifteen to twenty shots can be fired in the same time.

Breech-loading guns need no ramrod. All the soldier has to do in loading his gun is to open the back end, push in the CARTRIDGE, and shut it again, when it is ready to be fired. When the trigger is pulled the hammer strikes a little steel pin which is driven against the end of the cartridge where the percussion powder is, and this fires it. In opening the back end, the brass shell which held the powder and ball is thrown out, and the gun is then ready for another cartridge.

The rifle used in the United States navy was formerly the Remington, but is now the Lee. Many rifles were made in this country for Turkey during the war with Russia. Parts of these were Winchester rifles, but most of them were called the Peabody-Martini-Henry gun, because they were made up of parts of three different kinds of rifles bearing those names. The Martini-Henry rifle is English, but the Peabody is an American rifle. Another American rifle, called the Berdan, is used in Russia, and American rifles of different kinds are used in almost all the South American countries.

Repeating Rifles. Rifles that can fire several shots without reloading have been possible only since the invention of the metallic CARTRIDGE. Colt's repeating rifle, with six charges in a revolving cylinder, was used before that time, but it was not a safe gun, as it allowed the gas to escape between the cylinder and the barrel. A great many kinds of repeating rifles are now made, some for sporting and some for use in war. In the United States the first to come into general use was the Henry rifle, which carried a number of cartridges in a magazine under the barrel. This gun, which was much used by sportsmen and to some extent in our Civil War, has been improved into the Winchester, which was used by the Turkish cavalry in the Russo-Turkish War. It carried fifteen cartridges in the magazine under the barrel. In the latter part of our Civil War the Spencer rifle also was used, mostly by cavalry. In this the cartridges were carried in a tube in the stock.

Switzerland was the first nation to adopt a repeating rifle for its troops——the Vetterli, a magazine gun on the Winchester principle, which has now been superseded by

the Schmidt. The Germans followed, and almost every nation has since adopted some form of repeating rifle. There are too many kinds to describe all, but they may be divided into three classes according to the ways the cartridges are carried:

1. Those in which the cartridges are placed in a tube under the barrel, as in the Henry, Winchester, Bullard, Ward-Burton, Spencer (new model), Marlin, and Colt (new model), all American; the Mauser, German; the Lebel, French; the Jarman, Swedish; the Vetterli, Swiss; the Kropatscheck, French and Portuguese.

2. In which the cartridges are carried in the stock, as in the Spencer (old model), Hotchkiss, Maxim, Chaffee-Reece, and Meigs, American; and the Evans, American and Russian.

3. In which the cartridges are contained in a magazine just behind the cartridge chamber of the barrel, as in the Lee, Elliott, Burton, Lee-Burton, and Remington-Keene, American; the Mannlicher, Austrian; the Schmidt, Swiss; the Vitali, Italian; the Owen Jones and Lee-Metford, English; the Hebler, German; and the Krag-Jörgensen, Danish. The shape and arrangement of the magazine differs in the various guns, and in some the magaazine is fixed and in others it can be taken off and replaced by another one. Most of them carry five cartridges; but the new English (Lee-Metford) carries eight; and the new Swiss (Schmidt) twelve in two packets of six each.

In the war with Austria (1866) the Prussians used a breech loading paper-cartridge gun called the Dreyse needle-gun, because it was fired by a steel needle pushed into the cartridge by a strong spring when the trigger was pulled. After the war with France (1870-71) they adopted another breech-loader, the Mauser, in which a metallic cartridge was used. They next tried to change this into a repeating rifle by putting a magazine under the barrel, as in the Winchester rifle; but it was not satisfactory, and the government sold several hundred thousand of them to Turkey and China, and adopted in 1889 a new magazine rifle, called the Hebler, in which smokeless powder is used. This gun is only a modified form of an American gun, the Remington-Keene, which was tested by the United States Government in 1881. It carries five cartridges in a magazine that fits into the under side of the barrel. When all five shots are fired the magazine falls out, and the soldier puts in a new one as easily as he could put in a single cartridge.

In the war with Germany (1870-71) the French used a breech-loader called the Chassepot. In 1874 they adopted a new kind of breech-loader called the Gras, and in 1886 a repeating rifle called after its inventor the Lebel, in which smokeless powder is used. It carries eight cartridges in a tube under the barrel, like the Winchester. The bullet from this gun, it is said, will go through fifteen inches of oak plank at 220 yards.

The English rifle, called the Lee-Metford, is the American Lee rifle with a detachable magazine, working much like the German rifle, with the Metford system of rifling. The magazine holds eight cartridges. The Austrian Mannlicher rifle is the Lee renamed. It carries five cartridges. The Krag-Jörgensen has been adopted by the United States.

The word rifle is from the German *riffeln*, to cut a groove.

ROACH. See DACE.

ROBIN. The robin red-breast lives in the mild parts of Europe, and in western Asia and northern Africa. Its back is olive green, and its neck and breast light red. It has a sweet song, and loves to build its nests near dwellings, often putting them where there is great noise and confusion. This is the robin red-breast of poetry and song, the little

bird that covered the "Babes in the Wood" with leaves.

The **American Robin** is really a thrush and is about twice as large as the robin of Europe. It is usually olive gray on the back, white on the throat, and red on the breast. It is found all over North America. It comes north very early in the spring, and is sometimes seen in New England before the snow has left the ground. Its habits are very familiar, much like those of the English robin, and it was probably on this account that it was named after it by the early settlers. Its native song is not so sweet as that of its namesake, but it can be taught to imitate other birds and even to sing tunes. It builds its nest usually in trees near houses, lays four to six pale green eggs, and raises two broods each season.

The robin sits eleven days. On the eleventh day the young come out of the shell, and on the eighth their bodies are covered with pin-feathers. In eleven or twelve days more they leave the nest, and after a day or two they are left to the care of the male, who feeds and looks after them while the female is preparing for another family by building a new nest, generally not far from the old one. The young never go back to the nest after leaving it, as it is full of vermin. The vermin soon leave the young birds, for the robin is very neat and takes a daily bath. The robin lives mostly on insects. He sometimes likes a plump cherry in its season, but he does more good than harm to cherry orchards, for he eats thousands of worms and grubs that would destroy the trees if left to themselves.

The robin belongs to the order *insessores*, or perching BIRDS.

The word robin is a short form of Robert, which is from the old German *hrod*, fame, and *briht*, bright, fame-bright, a name given to the heathen god Thor, to whom the robin was sacred.

ROCKFISH, the name of a family of fishes found on the Pacific coast, called also Rock-cod, although they are not properly codfish. They are excellent food fishes and are largely caught on the California coast. They average fifteen inches in length and two or three pounds in weight, though some have been caught of twelve pounds. In southern California they are called garrupa or grouper. There are several kinds called in different places scorpena, black-banded rock-fish, tree-fish, speckled black, yellow, and red garrupa, grass rockfish, brown rockfish, flyfish, etc. The rockfish of the Atlantic coast is the striped BASS.

ROCKS. When we speak of a rock in common language, we mean a hard stone, but any kind of natural stone, whether it be hard or soft, is really a rock. In this sense, sand, clay, peat, and coal are as much rocks as sandstone or granite. There are a great many kinds of rocks, but they may all be divided into three classes: 1. Sedimentary Rocks; 2. Organic Rocks; and 3. Igneous Rocks.

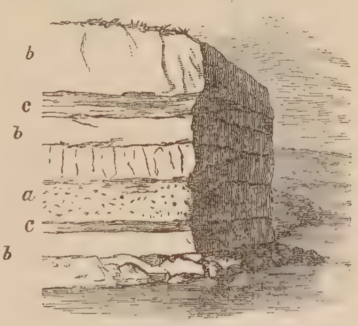
1. **Sedimentary Rocks** are those which are formed out of sediments (Latin *sedimenta*, settling). Sediment is something which has been mixed up with or moved along by water, and has finally settled to the bottom. If gravel be shaken up in a glass with water and then left to stand, it will at once sink to the bottom and form a sediment of gravel, If sand be shaken up in the same way, it will take longer to settle, but in a few minutes the water will become clear and a sediment of sand will be formed on the bottom. If mud be shaken up until thoroughly mixed with the water, it will remain dirty for some hours; but the clay will settle little by little, and at last a sediment of mud will be formed at the bottom.

Gravel, sand, and mud are all made in the same way and from the same things. They differ only in

coarseness; gravel is made up of stones worn round and smooth; in sand they are worn into grains; and in mud they are worn into fine dust. They all come from pieces of stone broken off from the cliffs of mountains and hills by the rains, springs, and frost, and washed down by streams and rivers. When the pieces first fall from their places they are not round but have sharp edges; but as the brooks sweep them along they lose their sharpness little by little by being rubbed against each other until at last they become rounded like cobble stones and gravel. As the stones grow rounder they grow smaller, and many of them are ground down into mere sand and fine dust. You will find plenty of rounded stones in the bed of every brook. As brooks and rivers are always flowing they are all the time grinding rocks into gravel, sand, and mud, and all the time carrying them down into the lowlands and thence into lakes and the sea. We say commonly that these things are worn by the water, but they really wear themselves down; all the water does is to keep them grinding against each other.

When water flows quickly it sweeps along both gravel and sand, and when it begins to flow slower it drop some of its load. The heaviest sinks to the bottom first and forms a layer on the bottom, then the next heaviest makes another layer, and lastly the light mud settles on the top. In some places many sets of layers are thus made one above another, sometimes to the depth of hundreds and thousands of feet. When gravel, sand, and mud are thus piled up in layers above each other in the beds of lakes and the ocean, the layers which are at the bottom are under a great weight and are squeezed into a much firmer mass than those above, thus becoming quite hard. The water of brooks and rivers also carries down with it a good deal of lime, iron, and other things dissolved in it, and these things become mixed with the sand and other materials and cement them together, so that they are made into a solid mass. The hardening of sediment into stone in this way is called infiltration, because the substance which binds the grains together filters through them. Thus, the gravel, sand, and mud swept into lakes and the sea by rivers is made into rock in two ways, by pressure, and by infiltration, Rock made out of gravel hardened or cemented together is called conglomerate (Latin *conglomeratum*, rolled together); it is also sometimes called pudding stone, because it looks like pudding with plums in it. Rock made from sand is called sandstone; and that from mud, shale (German *schale*, shell, from *schalen*, to peel or shell off), because it is in leaves or layers which easily scale off.

Now let us look at the side of a hill cut through from top to bottom as shown in the picture, so that we



Section of Hill, Showing Strata.

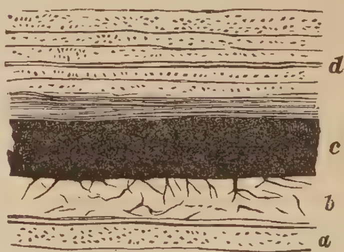
can see the layers of rock in it. Such a cutting is called a section (Latin *sectio*, a cutting), and each layer in it is called a stratum (Latin *stratum*, plural *strata*, a bed or layer). All sedimentary rocks lie in strata, and they are therefore often called stratified rocks. In the pict

ure, *a* shows a stratum of conglomerate; *b*, *b*, *b*, strata of sandstone; and *c*, *c*, strata of shale. It will be seen that they are not in regular order, but that they lie just as the gravel, sand, and mud of which they are made may have been washed in. In this case, the stratum at the bottom and the one at the top look to be the same, and they are really the same, only the one at the bottom is much older than the other. The strata are not always so easy to see as they are in the picture, for the rocks are often hidden by soil or otherwise, so that it is hard to tell one from the other.

Sedimentary or stratified rocks often have other things in them besides gravel, sand, and mud, among which the most important are the remains of plants and animals. Pieces of ferns and other plants are found bedded in these rocks, especially in sandstones and shales, which have been swept down with sand and mud by rivers and buried up in the layers. As the sediment hardened into shale these plants changed under the great pressure little by little until they finally became coal. In the same way the remains of shells, corals, fishes, and other animals have become buried in the sediment and hardened into rock. All such remains of plants and animals bedded in rocks are called fossils (from Latin *fossum*, dug, because they are usually dug out of the earth). By looking at the fossils in rocks we can tell whether the rocks were made in the sea or in lakes, because the plants and animals found in salt and in fresh water differ from each other. Most of our rocks have been made under the sea, and afterward raised up out of the water.

2. **Organic Rocks** are formed out of the remains of plants and animals. It has been shown how parts of plants and animals become mixed up in sedimentary or stratified rocks; but plants and animals sometimes form thick layers by themselves, which also turn into rocks. As these are not formed in the same way as sedimentary rocks, they are not classed with them, but are put into another class called organic rocks, which means rocks made up of organisms, or things which have had organs. Plants and animals live, move, and grow by means of organs; hence, when we speak of organic remains we mean fossils, or the remains of plants and animals.

COAL is an organic rock because it is made up of the remains of plants. It is found in strata, like sandstone and shale, among beds of sedimentary rock, and usually only a few feet thick. A section cut through a bed of coal and the rocks above and below it would look something like the picture. In this *c* is the layer or seam



Section of Coal Bed.

of coal, as it is called; *b* is a layer of hard clay or shale on which it lies, called therefore the pavement of the coal; and *a* is a layer of sandstones, shales, etc., under it; *d* shows layers of sandstones and shales, forming what is called the roof of the coal. Almost every seam of coal lies on a bed of clay like this. It is made up of dark clay, with black streaks and branches running down through it like the roots of plants. This is what they really are, and the bed of clay is merely an old soil, which used to be the top of the ground, and the bed of coal is made up of the plants which once grew on it. Each coal seam, therefore, has been in some past time a thick mass of vegetation growing

on a marshy plain something like the jungles in hot countries. These plains had a muddy soil, and it is this which now forms the pavement under the coal seam. The leaves and stems of these plants have been so squeezed together that we can seldom find any of them in the coal itself, but parts of them are often found beautifully preserved in the layers of shale and sandstone above and below the coal. A few of the plants out of which coal was made are shown in the pictures. These grew and died long before any of the plants which now live on the earth were known.

PEAT is formed in much the same way with coal; indeed, if left long enough it would become coal. If a peat bog be cut through, on the bottom will be found a layer of clay, which once formed the bed of a lake, and above this lies the peat, made up of the vegetable matter formed from the decayed roots, stems, and leaves of the plants which grew in it.

Rocks are formed out of the organic remains of animals as well as of plants. The bottoms of many lakes are covered with a kind of chalky mud called marl, made up of the decayed and decaying shells of animals which lived in it. Sometimes the beds of dried-up lakes are dug up to get the marl to use as a manure on land, and these layers of decayed shells have been found many feet thick. But on the great bed of the ocean these beds of shells are hundreds and even thousands of feet thick. As sea animals die their shells and bones gather on the bottom and make a layer which is all the time growing thicker and thicker. Some of this has been brought up from the bottom of the ocean by means of the DREDGE; when looked at under the microscope it is seen to be made up mostly of small shells called foraminifera, some of which are whole and some broken. If now we look at a piece of chalk in the same way we shall see that it is made up of just the same things, and we therefore know that it is a stone made out of the remains of once-living animals, and that it has been formed under the sea. Not only chalk, but almost all the rocks called limestones were formed in the same way. As great ranges of hills and cliffs hundreds of feet high in different parts of the world are made up wholly of chalk, and as some of the highest mountain chains, such as parts of the Alps and the Himalayas, are made up of limestones, we are led to wonder how these masses were raised from the bottom of the sea and pushed so high up above the surface of the land. We shall find out how this came about by studying the third class of rocks.

Plants from which Coal has been made.

3. **Igneous Rocks** are those which have been melted within the earth or have been thrown up by volcanoes. Igneous (Latin *ignis*, fire) means fiery, and igneous rocks are so called because they have been

formed chiefly by the action of fire inside the earth, which is told about in the article EARTH. Igneous rocks may be divided into two groups: the crystalline and the fragmental.

Crystalline igneous rocks are made up of crystals which have once been melted. It is told above that plants and animals are called organic, because they live and move by means of their organs. Mineral substances have no organs, and are therefore called inorganic substances. When most inorganic substances become solid, they form crystals. For example, ice, which is water become solid, is merely a mass of crystals. Indeed, the Greek word crystal (*krustallos*) means ice; but we use it to mean the form taken by any kind of mineral matter in becoming solid. Thus, lava, granite, quartz, iron, limestone, the diamond, and all the solid materials of the globe are made up of crystals. But when we speak of crystalline rocks, we usually mean those whose crystals were formed by the action of fire. GRANITE is a good example of crystalline igneous rock. It is made up of three different substances, in each of which the crystals are of different form. The crystals of feldspar are long and smooth-faced and of a pale flesh color or dull white, those of mica in bright thin plates, and those of quartz in little grains, hard, clear, and glassy. All these are mixed together without any order through the whole stone. There are many high mountains formed almost entirely of granite, yet we have reason to believe that it was melted and cooled into crystals deep down in the earth under other rocks. How it came up to the surface of the earth and was piled up above it in great mountains is told about on page 633. There are many other kinds of crystalline igneous rocks, most of which were thrown out from volcanoes in the form of lava, and hardened into crystals on the surface of the earth. Basalt, one of these, is often found in regular columns, like those in the Giant's Causeway in Ireland. These were formed by the contraction or drawing together of the melted lava in cooling.

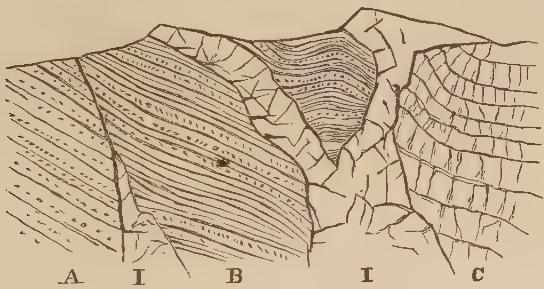
Fragmental igneous rocks are made up of fragments, such as bits of lava and other rocks, ashes, and dust, which have been thrown out from volcanoes. These become packed together closely and form the rock called tufa. In some places tufa is found in masses many hundred feet thick, and in the layers are often seen shells and other sea fossils, which show that the materials of which the tufa was made fell into the sea and there became cemented into rock.

We have thus shown that the rocks on the earth may be divided into three classes: Sedimentary rocks, formed by the settlings of gravel, sand, and mud mostly on the bottom of the sea; Organic rocks, made up of masses of animal and vegetable matter; and Igneous rocks, formed by the action of fire inside of the earth. The whole top of the earth is made up of the these three classes of rocks. How far below the surface they go we cannot tell, but we find the same kinds of rocks as far down as we are able to dig. This solid rocky top of the earth is called the earth's crust, a name which was given to it when it was thought that the globe was made up of a hot liquid mass inside, with a rather thin cool crust over it. We do not yet know whether the main part of the inside of the earth is liquid or solid, but it is generally believed that at some past time, millions of years ago, our globe was a burning mass much like the sun, of which it once formed a part and that it has been cooling little by little, through all that time. The crust has thus become cool and solid, but the inner part still keeps a good deal of heat. You may think that if the inside is so hot, the outside ought to

be warmer than it is; but rocks are bad conductors of HEAT, and so the great heat of the inside passes off very slowly.

It has been told in HEAT that almost all bodies swell when they are heated, and shrink when they are cooled. When the earth was very hot, therefore, it must have been much larger than it is now, and it must have shrunk a good deal while cooling. This must have caused a great strain on the crust, so that some parts of it became ridged and others sunken, like the shrivelled skin of a dried apple. Changes somewhat like this have been always going on, and are still going on in different parts of the world through the action of volcanoes and earthquakes, so that in some places the land is rising little by little, while in others it is slowly sinking below the sea. Thus it has happened that the sedimentary rocks at the bottom of the sea have been raised up so as to make great mountains, and that organic rocks, made by the decay of vegetable matter on the surface of the earth, or by the packing together of shells and other animal matter on the bottom of the sea, have been forced out of their places, so that some, like coal, are buried deep down in the earth, and others, like chalk and limestone, are raised high above the surface of the land.

But other changes have also taken



Fault, showing Igneous Rocks, I I, forced into Cracks between Sedimentary Rocks, A, B, C.

place. The rocks have not only been lifted up and sunk down; they have also in many places been crumpled up and broken. Hence the crust of the earth, instead of being in flat layers, as it would have been if the rocks had been left as they were made, has been so squeezed and broken that the oldest rocks often lie higher than those which were made last. Thus it happens that the stratified rocks are seldom found in level layers, but generally lie slanting, and sometimes so tilted as to stand on end. Sometimes, too, the strata are all crumpled and folded together, and sometimes they are broken in two and those on one side of the crack are shoved up much higher than those on the other, so as to make a break in the layers. Such a break is called a fault. This often happens in coal seams, and gives miners much trouble. When strata are thus broken, melted igneous rocks have often been forced up from underneath so as to fill up the crack, and thus granite and other igneous rocks are often found in veins between other kinds of rocks. In the picture two such veins of igneous rocks are shown at I, which have been forced in between stratified rocks so that they have been broken into three parts, A, B, and C. In two places the igneous rocks have risen to the

surface of the earth and formed hills and mountains.

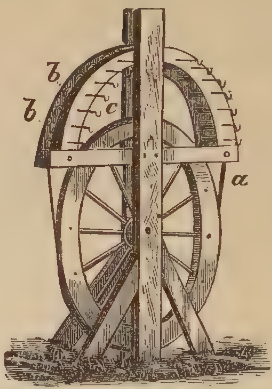
So well have most of these rocks preserved their story, that we can tell a good deal about the history of the earth by looking at them. We know the order in which the different kinds were formed, so that we can tell where each one belongs, notwithstanding that they are now mixed up together, or that the oldest kind may be piled on top of the newest. The fossils in rocks, too, tell much of their history, for the plants and animals in the early ages of the earth were much different from those of to-day. Each division of rocks, therefore, has its own kind of fossils, and this is of great help to us in separating the divisions from each other.

The word rock is found in many languages: in French it is *roc* or *roche*, in Spanish *rueca*, Portuguese *roca*, in Italian *rocca*, in Danish *rok*, Swedish *rock*, and Icelandic *rockr*, and is allied to Latin *rupes*, rock.

ROOK, a bird of the crow family, about the size, form, and color of the common crow, but having the base of the bill covered with a rough skin, which in old birds is whitish. Rooks are found all over Europe and are abundant in Great Britain. They live together in rookeries all the year round, building their nests, seeking food, and roosting in flocks. Their nests, which are built in tall trees, sometimes in the middle of cities, are used year after year. They are often seen in groves around old mansions, where they are protected and where sometimes houses are built for them. They live on worms, shell-fish and crustaceans, insects, nuts, seeds, and grain. Many of their young are shot in the spring for food.

The rook belongs to the order *insessores*, or perching BIRDS. The word rook is from the Anglo-Saxon *hroc*, rook, named probably from its croak.

ROPE, a large, stout, twisted cord, usually more than one inch round. When smaller than this, it is called a cord. Ropes are usually made in a rope-walk, a long, narrow, one-story building, one end of which is called the head and the other end the foot. At the head is a spinning-machine,



Rope Spinning Wheel.

a large wheel between two posts, which turns by means of a belt, *a*, a number of little rollers, *b*, *b*, ending in small hooks, *c*, *c*. The second picture shows one of these enlarged. When the wheel is turned, these hooks, which are called whirls, turn round very rapidly. There are generally about twelve whirls in a spinning-machine, so that twelve spinners can spin at once. Each spinner wraps loosely round his body a bunch of hemp, pulls out a few threads and fastens them to one of the whirls or hooks of the spinning-wheel, which is turned by an assistant, and walks slowly backward down the ropewalk, letting the threads draw out little by little and evenly through his fingers. The turning of the whirl keeps the thread twisting all the time, and the spinner keeps on thus until he gets to the foot of the walk. As he goes along he hangs the thread,

Whirl.

which is called a yarn, on hooks on the cross-beams, so that it shall not fall on the ground. When the yarn is done, it is wound up on a reel, and the spinner spins another one.

After spinning the yarns, the next thing is warping, in which enough yarns for a rope are stretched out to an equal length. If they are to be made into tarred rope, they are drawn through a kettle of hot tar, and afterward through a hole which scrapes off the tar where there is too much of it. Several yarns, usually three, are now fastened to a whirl-hook and twisted together, but in the opposite way from that in which they were first twisted. This is called laying, and the cord thus made, a strand. When three such strands are twisted together it is called the first lay, and the rope made is called a hawser-laid rope; and when four strands are used, it is called the second lay, and the rope is said to be shroud hawser-laid. The third lay is the twisting together of three hawser-laid ropes, when it is said to be cable-laid. This makes the largest kind of rope, called a cable, used for mooring and anchoring ships; but chain cables have now almost altogether taken their place.

Ropes are now largely made by machinery, by which they are spun much more evenly than by hand. Ropes of iron wires twisted together are much used for the rigging of ships, and for cables for suspension bridges. They are much stronger than those made of hemp.

The word rope is from the Anglo-Saxon *rap*, rope.

ROSE. It is not known from what country the rose first came, but it has been common from the most ancient times. There are a great many kinds of roses, and some are among the most beautiful of flowers. There are several wild kinds in the United States, among which are the prairie or Michigan rose, blooming in July, from which some of the cultivated double pink roses have descended; the dwarf rose, which blooms from May to July; the swamp rose, found usually in damp ground, and which blooms from June to September; and the early wild rose. The Cherokee rose, much used in the Southern States to make hedges, was brought to this country from China before the Revolution. Among the cultivated roses, the red French or Provence rose, commonly called the summer or June rose, was brought from Syria to France in the time of the Crusades. The cabbage rose was first brought from the Caucasus Mountains, and the damask rose from Damascus. The moss rose was first carried to England from Holland in 1596. The yellow rose came from Persia, and the musk rose from Persia, China, or India. The rose is chiefly valuable for the perfumes made from it. The otto, ottar, or attar of roses (so called from an Arabic word meaning to smell sweetly) is an oil distilled (see ALCOHOL) from the petals or flower leaves of roses. It is made chiefly in India and European Turkey, but some is made in the south of France. It is very costly, as it takes 4000 pounds of rose leaves to make one pound of attar of rose. What is left after the attar is distilled is made into rose water. Damask and musk roses are chiefly used in making attar.

The word rose is from the Latin *rosa*, Greek *rhodon*, rose.

ROSE-FISH, a fish of a brilliant scarlet color, found on the Atlantic coast of North America from New York northward. It is sometimes called red perch to distinguish it from the cunner or blue PERCH, which it resembles in form. It is called also Norway haddock, hemdurgan, and bream, and in Nova Scotia, John Dory. The rose-fish is from 8 or 10 inches to 2 feet long, and weighs from a half pound to 10 pounds. It is an excellent food fish

and is much caught along the coasts of Massachusetts and Maine; but the largest fisheries are on the coast of Greenland, where it is highly prized both for its flesh and for its spines, which are used for needles.

ROSEMARY, a sweet-smelling shrub which grows wild along the coast of the Mediterranean. An essential OIL is distilled (see ALCOHOL) from it, which is used in perfumery, and in medicine to give a pleasant odor to liniments and lotions.

The word rosemary is in Old English *rosemarine*, and is from the Latin *rosmarinus*, rosemary; from *ros*, dew, and *mare*, the sea. It is so called because it grows best near the sea.

ROSEWOOD, the wood of several kinds of trees, which has an agreeable smell much like that of roses, especially when sawn or cut. It is usually dark-red, beautifully veined with brownish-black or dark-red shades and stripes, and is much used for ornamental furniture and cabinet work. It is very costly, and is chiefly used as a veneering or thin covering for other woods. The finest rosewood comes from South America, especially from Brazil, but some is brought from Jamaica and some also from the East Indies.

ROW-BOAT, a boat moved by means of oars. Row-boats differ much in form and size according to the uses to which they are to be put, and are given various names. The principal row-boats on a ship of war are called the launch, barge, gig, pinnace, cutter, jolly-boat, and yawl. The launch is a large flat-bottomed boat, used mostly to carry wood, water, and other heavy things from the shore to the ship. The barge is a long, narrow boat used by the principal officers in going to and from shore, and usually has eight oars. The gig is a long, light boat, rowed by six or eight oars, used for going long distances. The pinnace is used by the lower officers, and has usually eight oars. The cutter is rowed with six oars, and is used by the crew and for carrying light stores. The jolly-boat is much like the cutter, but smaller, and has only four oars. The yawl is a wide, short boat, rowed by four or six oars. Among other kinds of row-boats are wherries, skiffs, punts, canoes, and dories. The wherry is a light, long, and narrow boat, sharp at both ends, and used generally by only one person for fast rowing. A skiff is a short, light boat, rowed by one or two persons. A punt is a shallow flat-bottomed boat, used for duck-shooting, etc. A canoe is a long narrow boat, made usually out of a log or of the bark of a tree; when made out of a log it is sometimes called a dugout. A canoe is also sometimes called a dory, but a dory is commonly flat-bottomed. A whale-boat is a long, deep boat, sharp at both ends, and rowed with five or seven oars. In boat building, a boat is said to be carvel-built when the planks on her bottom and sides are put on flush or smooth, that is, with the edge of one plank resting on the edge of the next one; and clincher built, or lap-streaked, when the planks overlap each other like clapboards on a house. Sailors usually call the seats of a boat thwarts, because they are athwart or across the boat. The gunwale, or gunnel, is the board on the upper edge of the boat; the rowlocks, or places for holding the oars while rowing, are sometimes hollows cut in the gunwale, sometimes a pair of pins, called thole pins, between which the oar rests, and sometimes of a single pin, to which the oar is fastened. Boats are rowed by either oars or sculls. Oars are usually longer and heavier than sculls, and each one is used by one man, who takes hold of it with both hands; but in rowing with sculls, two are used by each man, one being held in each hand. Sweeps are very long and heavy oars used for rowing large vessels in

calms, each one being worked by several men.

Racing Row-boats are very different from common row-boats, being very long and narrow, and made so light that they can easily be carried by their crews. They are so very thin that they are called "shells." They are made of various sizes, and are usually named from the number of pairs of sculls or of oars used in them. A single shell is rowed by one man with one pair of sculls, and a double shell by two men, each using a pair of sculls. Four-oared, six-oared, and eight-oared shells are rowed by four, six, and eight men, each using a single oar. Shells are made usually of a light wooden frame covered with a thin plank, called the skin, made of cedar, mahogany, or pine. The skin is sometimes no thicker than the cover of a cigar box, and great care has to be taken lest it be split or twisted out of shape. Instead of wood the skin is often made of paper formed by pasting sheets on a pine model, which is taken out when the skin is dry. The skin is then made water-proof, and has a frame put into it to keep it in shape. The boat is open only in the middle, where the rowers sit, and around this is a board called the washboard, made to keep the water out. The two ends of the boat, before and behind where the rowers sit, are covered usually with oiled linen or silk, but sometimes with thin wood. The rowlocks of a racing boat are not made like those in a common row-boat, but are put a good way out from the side of the boat, on strong iron rods called outriggers. This is done because if the rowlocks were on the gunwale of so narrow a boat, the oarsmen would scarcely be able to pull at all. In rowing, the oarsmen sit with their backs to the bow of the boat, and the steering is usually done by the man in the bow, who works the rudder with his feet by means of long wires which run along the bottom of the boat. The oars of racing boats are not made with flat blades like those of common boats, but are hollowed out so as to take hold of the water better. They are commonly called scoop or spoon oars.

The word row-boat is from the Anglo-Saxon *rowan*, to row, and *bât*, boat.

RUBY, a beautiful red PRECIOUS STONE. Some rubies are rose-color, and some are so dark as to be nearly violet or brown. The oriental ruby, the most valuable kind, fine specimens being worth much more than the diamond, is of the shade of red called "pigeon's blood." The finest ones are brought from Ceylon and Burmah. The ruby mines of Burmah belong to the crown, and one of the king's titles is "lord of the rubies."

Artificial rubies are now made in France which are as hard and of as good color as real ones; though no very large ones have been produced. They have been tried as pivots in watches and found to be as good as natural stones for that purpose.

The word ruby is from the Latin *ruber*, red.

RUM, a liquor distilled (see ALCOHOL) from the skimmings of sugar pans in making sugar, from sugar cane juice, or from molasses. It is largely made in the West Indies, particularly in the islands of Santa Cruz and Jamaica. Some is also made in the United States, chiefly in New England, from which it is called New England rum. A kind made in Massachusetts is called Medford rum. New England rum is distilled mostly from molasses. Pure rum is generally light colored, but Jamacia rum is colored reddish brown with caramel (see SUGAR). Rum is sometimes flavored with the fruit of the guava tree, and sometimes with PINEAPPLE.

The word rum is said to be shortened from rumbullion or rumboose, names used for this liquor in the seventeenth century.

RUSH, the common name of a great number of plants, which look much like the grasses, but which are more like the lilies. Rushes grow usually in wet places; tufts of them may often be seen in swamps and in wet pastures. In former times, before carpets came into use, the floors of houses were strewn with rushes; and candles were made with the pith of rushes for wicks. The bottoms of chairs are sometimes woven of them, and they are also used for weaving mats and small baskets.

The word rush is from the Anglo-Saxon *risc*, from *hriscian*, to make a rustling noise, and the rush was so called from its sound when moved by wind.

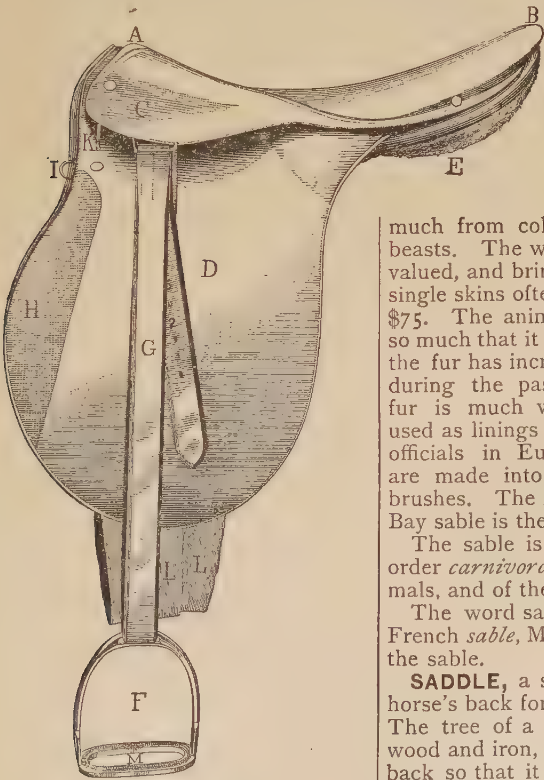
RYE, the plant and grain of one of the cereal (see CORN) grasses. It looks much like wheat, but its ears, as will be seen in the picture, are bearded like those of barley, though the beard is not quite so long. The grain is brown, and is harder and rather coarser than that of wheat. Bread made from it is very dark, and is not so good for food as that made from wheat, but it is largely used in the countries around the Baltic Sea. In Sweden, the common people live largely upon rye cakes, which are baked but twice a year, and are therefore so hard that they have to be cut with a hatchet or saw. In New England, rye flour is used with Indian meal in making brown bread. Much whiskey is made from rye in this country; in Holland it is used with barley for making gin; and in Russia a liquor called *quass* is distilled (see ALCOHOL) from it. The straw of rye is tough and not good food for cattle, but is used for making STRAW hats, for stuffing beds, horse-collars, and other things, and for thatching the roofs of buildings. Rye does best in a cool climate, and probably grew first in north-western Asia and north-eastern Europe. The ancient Egyptians and Greeks did not know it, and it was not raised in Italy until about the time of Christ.

Head of Rye.

The word rye is from the Anglo-Saxon *rige*, rye.

S

SABLE. This little animal, so much prized for its fur, is found mostly in the wilds of Siberia, and in the cold mountains between European and Asiatic Russia. It is much like the weasel (see picture on page 461) in shape and size. Its fur in summer is brownish, with gray spots on the head and neck, but in winter it is a deep rich brown. The sable spends most of the day in trees, and hunts by night, living chiefly on hares and other small game. Many of the Russian exiles employ themselves in hunting the sable, and as it lives in the coldest and most rugged places, they suffer much from cold, hunger, and wild beasts. The winter fur is the most valued, and brings very high prices, single skins often selling for $50 to $75. The animal has been hunted so much that it is getting scarce, and the fur has increased much in value during the past few years. Sable fur is much worn by ladies and used as linings for the robes of high officials in Europe, and the tails are made into artists' pencils and brushes. The American or Hudson Bay sable is the pine MARTEN.



English Saddle.

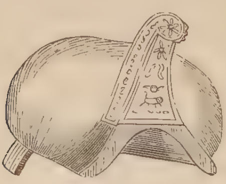
The sable is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family.

The word sable is from the Old French *sable*, Middle Latin *sabellum*, the sable.

SADDLE, a seat to be put on a horse's back for a rider to sit upon. The tree of a saddle is a frame of wood and iron, made to fit a horse's back so that it does not rest on the backbone but presses on the back each side of it. Some trees are nearly flat on top, and some are raised up high both in front and behind, but the most common saddle is like the one in the picture. In this

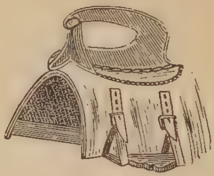
the tree is raised a little in front to form the pommel A, and behind also in a rounded ridge, B, which is called the cantel. The seat of the saddle, is made by stretching tightly over the tree a tanned pigskin, which is very tough and wears well. The flaps, D, are also made of pigskin. The stirrup leathers, G, which hold the stirrups, F, are fastened to the tree under the "skirt," C, and fall over the flaps. Under the saddle are false flaps, E, padded so as not to hurt the horse's back, and between the flaps and the false flaps lie the girths, L, which are buckled to straps fastened to the tree. H is the roll, where the forward part of the flap is often stuffed, preventing the rider's knee from going forward when the horse is pulling hard or jumping. K is a staple for fastening the breast plate to prevent the saddle moving back, and I is for fastening the hunting flask. When the saddle is put upon the horse, the girths are passed under the belly and buckled tightly to straps under the other flap.

Side Saddles, used by women, are made in nearly the same way, but have only one stirrup in which the left foot is placed. On the pommel



Queen Elizabeth's Saddle.

of the saddle are two pieces called horns, between which the right knee is put. Sometimes a third horn, called the hunting horn, is put on the side, under which the left knee is placed. This gives the rider almost as firm a seat as can be got in the man's saddle. In old times women's saddles were made without horns, but with a high pommel to hold on to. The second picture shows the side saddle of Queen Elizabeth, which is still to be seen at Horsham Hall, Essex, England. The seat is a velvet cushion, and the pommel is



Icelandic Side Saddle.

of metal gilded. In the third picture is shown a kind of side saddle used by women in Iceland. It has a seat with a back, like a common chair, and has instead of a stirrup a little shelf on which both the feet can rest.

The stirrups of children's saddles are sometimes so made that the stirrups will open at the side if the rider is thrown. This lets the foot out at once, and saves him from being dragged on the ground in case the horse runs away.

The word saddle is from the Anglo-Saxon *sadel*, Latin *sella*, a seat or saddle, from *sedere*, to sit.

SAFE, a strong box or closet to keep money and valuable things in, safe from burglars and from fire. They are usually double wrought IRON chests, filled between the two parts with some substance which is a non-conductor of HEAT, such as plaster of Paris (see GYPSUM) and MICA, plaster of Paris and alum, fire-clay and chalk, etc. The iron plates on the outside are made thick and tough, so that burglars will find them hard to bore through, and the doors are fitted with strong LOCKS which are hard to pick. Small safes are made for dwelling-houses, to store silver plate in, and very large ones for banks and stores, to keep money and papers in.

Valuable papers, jewels, money, and other property have often been

preserved unharmed in safes through great fires which burned down the buildings in which they stood. In the great fire in Chicago, in 1871, when a large part of the city was burned, many valuable things were saved in safes, though most of them lay in the burning ruins for several days before they could be got out.

The safe is so named because it keeps things safe. The word is from the Latin *salvus*, safe.

SAFFLOWER, a dyestuff made from the flowers of a thistle-like plant which grows in the south of Europe, in Egypt, and in Asia. It is wrongly called SAFFRON in the United States. In the East Indies, whence the most is brought, the flowers are dried, pressed into little cakes, and then packed in bales. Several beautiful tints, rose-color, pink, scarlet, and crimson, are obtained from safflower and used for dyeing silks and cottons. Rouge is also made from it.

The word safflower is made from SAFFRON and flower.

SAFFRON, a yellow coloring matter obtained from the stigma, or centre part, of the FLOWER of a kind of crocus. The petals of the flowers are violet or purple, and the stigma orange red. Much labor is required to pick the stigmas, and saffron is therefore costly. It has an agreeable perfume, and is used for flavoring and coloring confectionery, cheese, and butter. It was formerly used as a medicine, but is now known to have no value. A weak tea made from it is sometimes given to canary birds when shedding their feathers. Saffron is brought mostly from Spain, France, and Germany.

The word saffron is in Spanish *azafran*, from Arabic *za'faran*, from *safra*, yellow.

SAGE, a sweet smelling plant with a scent somewhat like that of camphor, and a warm bitterish taste. It is usually dried as an herb, which is used for flavoring sausages, cheese, soups, and other dishes. It is also used in domestic medicine as a tonic, and as a gargle for sore throat.

The word sage is from the Latin *salvia*, sage, which is from *salvere*, to save, and the plant was so named because it was thought to save sick people.

SAGO, a kind of food prepared from several kinds of palm trees, which grow in China, Japan, the East Indies, Ceylon, and the islands of the Indian archipelago. The trees are cut down as soon as they show signs of flowering, which takes place when they are fourteen or fifteen years old. If allowed to blossom and bear fruit, they die soon after. The trunk is split into pieces and all the inside, which is soft, white, and spongy, is scraped out and beaten in cold water until all the starch or sago is separated. This, which is the heavy part, settles to the bottom, leaving the woody fibre floating. The water is then poured off, the sago dried, and afterward pounded up, sifted, and packed in boxes or bags for sale. In this state it is called pearl sago, from which puddings are made; and which is much used as food for the sick. In the warm climates where it grows, it is made into bread, and is the chief food of millions of people. A good deal of false sago, made from potato starch, is sent from Germany and sold for East Indian sago.

The word sago is from *sagu*, the Malay name for it.

SALMON, the common name of a family of fishes which includes the TROUT, SMELT, whitefish, and others. Salmon are found in the northern parts of North America, Europe, and Asia; but there are none in South America or in Africa. They live both in the ocean and in fresh waters, usually going up the rivers in the spring and early summer, and spawning in the shallow streams. They can swim very fast, even against a strong current, and will often jump dams and waterfalls ten to twelve feet high. When they

reach their spawning place they dig a little trench in the sand on the bottom, lay their eggs in it, cover them with gravel, and return to the sea. The eggs lie all winter, and hatch out in March and April. The young stay in fresh water about a year, when they are about six inches long, and then go down to the sea.

The common salmon of the Canadian and New England rivers are slaty-blue on the back and silvery-white beneath. They are usually about three feet long and weigh ten to twenty-five pounds, but some are caught which weigh more than fifty pounds. The flesh of the salmon is a reddish yellow. The fresh salmon sold in our markets come mostly from Maine and from Canada. Pickled and canned salmon are brought chiefly from the Pacific coast, especially from the Columbia river in Oregon, where great numbers are caught every year.

There are five kinds of salmon on the Pacific coast, all different from those of the Atlantic coast: the quinnat or king salmon, the blue-back salmon or red-fish, the silver salmon, the dog salmon, and the humpback salmon. All of these are found in the waters of Oregon and Alaska. The quinnat, the kind found in the Columbia and Sacramento rivers, is the one mostly canned and is the most valuable fish of the Pacific coast. The blue-back, found in the Frazer river, is also canned, but it does not bring as high a price as the quinnat. The silver salmon is found chiefly in Puget Sound, and the other kinds in all the small streams.

Many salmon are now raised artificially, and some of our rivers, where they had become very scarce or had disappeared altogether, have been stocked again with them, so that they are becoming plentiful once more. The same thing is being done in England, the rivers of the north part of which were once so full of salmon that this fish was the cheapest of foods. Indeed, it is said that workmen were fed on it so much that they became sick of it, and it was a common thing for men when hiring out to bargain that they should have salmon to eat only three days in the week. But now salmon is a delicacy in England and can be enjoyed only by the rich.

The word salmon is from the Latin *salmo*, salmon.

SALMON TROUT. This fish, found in the great lakes of North America, and therefore often called lake trout, is the largest of the trout family, sometimes reaching a hundred and twenty pounds. It is caught in Lakes Superior, Michigan, Huron, and Erie, but not in Ontario, the Falls of Niagara preventing its passage; and also in Lake Champlain and some smaller lakes. The Indians called this fish *namaycush*. It is sometimes called also Mackinaw trout. Salmon trout are caught by gill-nets sunk to the bottom, by set lines, and in some seasons by trolling. In winter they are speared through a hole in the ice.

SALT. Common salt is in chemical language sodium chloride, being a compound made up of one part of SODIUM and one part of CHLORINE. When pure it is colorless and transparent, that is, so clear that one can see through it. It is obtained from three sources; beds of rock salt, salt springs, and sea-water. When rock salt is pure it is mined like other minerals, but when it is mixed with earth and other impurities, water is let into the salt and left there until it dissolves it, and the brine is then pumped out and evaporated—that is, the water is made to pass off as steam or vapor and leaves the salt.

Rock Salt. There are immense mines of rocks salt in Germany and in Austria. That at Wieliczka, near Cracow, in Poland, is more than a quarter of a mile deep and has five hundred miles of streets and galleries cut through solid salt. In some

places are large rooms more than one hundred feet high. One of these is fitted up as a chapel, in which the altar, pulpit, and statues are all carved out of salt. There are other great mines of rock salt at Stassfurt and Anhalt, in Prussia, and in Cheshire, England, and there are hills of salt in Spain and in other parts of the world. In the United States rock salt is found only in Virginia and in Louisiana. One of the most wonderful salt mines in the United States is at Petite Anse, an island on the coast of Louisiana, where, at a depth of 15 to 25 feet, is found a deposit of very pure rock salt, more than 1000 feet thick. In Lincoln County, Nevada, are great salt mountains containing, under a layer of sandstone two to eight feet thick, an immense deposit of rock salt as clear as glass.

Salt Springs and lakes are found all over the world, and much of the salt of commerce is made by boiling the brine until the water passes off as steam, leaving the solid salt in the pans. If the brine be boiled down quickly, a fine-grained table salt is made; but if it be boiled slowly, the product is a hard coarse salt. The principal salt springs in this country are in New York, Pennsylvania, West Virginia, Missouri, Ohio, and Michigan; and there are salt lakes in Minnesota, California, Utah, Nevada, New Mexico, Texas, and other States. The most important ones are those at Syracuse, New York, where many hundred men are employed. There are also salt wells in different parts of the United States, made by boring very deep into the earth. About four-tenths of the salt made in the United States comes from New York, four-tenths from Michigan, one-tenth from Kansas, and the rest from other States.

Sea Water Salt. Much salt is made from sea water in the West Indies, especially in Turk's Island and other of the Bahamas. This salt is usually hard and coarse, as the water is driven off slowly by the sun and not by boiling.

Salt makes a part of almost all kinds of food, and is necessary to the health and even to the life of man and animals. Each person eats about two ounces a week in bread alone. It is said that an old method of executing criminals in Holland was to feed them solely on bread made without salt, which soon brought on a fatal disease. It is largely used for pickling fish, meat, and vegetables, for making common SODA and CHLORINE, for glazing EARTHENWARE, and many other things. As some countries have no salt, it is one of the most important articles of commerce. In some parts of Africa it is so scarce that to say that a man eats salt with his victuals is as much as to say that he is rich; and a child will suck a piece of rock salt as if it were sugar.

In Russia it is customary to give bread and salt to a stranger as a mark of friendship, and among the Arabs a man who has eaten salt with another one looks upon him as a friend even if he had been an enemy before. The Hebrews, Greeks, and Romans prized it so highly that they used it in all their sacrifices. There are many superstitions about salt. For instance, some people think it unlucky to spill salt between them and a friend. This has grown out of the ancient belief that salt is incorruptible—that is, that it will not decay, and it was therefore made the symbol of friendship; and if it fell between persons it was thought that their friendship would soon end.

The word salt is from the Anglo-Saxon *sealt*, Latin *sal*, salt.

SALTPETRE, or NITRE, a white salt, without smell, and with a cooling, bitter taste. It is rightly potassium nitrate, and is made up of POTASSIUM, NITROGEN, and OXYGEN. In many places it is found in limestone caves, but it is chiefly obtained from the soil of certain warm countries, especially Egypt, Persia, and

India, where it appears as a white salt on the surface of the ground. About an inch of the earth is taken up, and soaked in water in large tanks; the water is then drawn off and allowed to dry up, when the saltpetre is found in the bottom of the tank. The principal use of saltpetre is for making GUNPOWDER, but it is also used in the preparation of sulphuric and of nitric acid, in making FIREWORKS, and in medicine, especially in cases of sore throat and rheumatism.

The word saltpetre, which means salt of rock, is from the Latin *sal*, salt, and *petra*, a rock; and the salt is so called because it is found on the rocks of caves.

SALTS. In the article BASE is told how the union of the substances called ACIDS with those called bases forms a new class of substances, which are unlike either of them. These new substances are called salts, because most of them have a general likeness to common salt, which was one of the first salts known. But all salts are not like common salt. SALTPETRE and ALUM are much like it, but chalk is entirely different; yet chalk is a salt made by the union of CARBONIC ACID with the base LIME. Glass is still more unlike it, but as glass is a compound formed by the union of silica or silicic acid with bases, such as potash, soda, and lime, it is properly a salt.

SAND, fine grains of stone, especially of QUARTZ, silica, (see SILICON) or FLINT, made by the wearing out of ROCKS. Sand differs in fineness, in sharpness, and in color. River sand and sand dug out of pits are usually sharper than sea sand, for this has been rounded by the washing of the waves. The colors of sand are made by various oxides (see OXYGEN) of iron. Sand is used in making glass, mortar and cement, SANDPAPER, and sand or hour glasses, in making moulds for casting iron, brass, and other metals (see METAL WORK and STATUE), in sawing and polishing building stones, and in grinding and polishing cutlery.

Sand Blast. This is one of the most wonderful uses of sand, by means of which glass, stone, metals, or any other hard substance may be cut or engraved. If a stream of sharp sand be let fall from a high box (as high as the ceiling of a room) through a tube on to a plate of glass held under it, the sand will cut away little grains of the glass till at length the whole surface will be cut or scratched and it will look like ground glass. If, instead of cutting the glass all over, it is wanted to engrave a pattern or figure on it, the workman has only to cover the parts of the glass which he does not want cut with a stencil plate made of leather, rubber, paper, wax, etc., for the sand will not cut any soft substance. By this means only the uncovered parts are cut, and when the stencil is taken off the pattern will be seen.

Glass Plate.
Engraved by Sand Blast.

Mr. Tilghman of Philadelphia, who first found out how to do this, has made a machine in which the sand is blown on to the thing to be cut by a blast of air or steam. The sand is thus made to act with greater force, cutting much more quickly, and the air or steam blows away the sand as fast as its work is

done, and leaves the plate clean so that the workman can see it. Glass signs, glass globes for lamps, and gas-burners, tumblers, goblets, and other glassware may be engraved in this way very fast and with the most beautiful designs. A glass plate engraved by the sand-blast is shown in the picture. Metals and stones also may be cut by means of the sand blast, which will not only scratch the surface but will cut it away to any depth. The marble tombstones put up in the national cemeteries to the memory of soldiers killed in the war were made in this way. Iron letters were fastened on to the smooth face of the stone, which was then put under the sand-blast, and the sand cut away all the marble not covered by the letters. When the iron patterns were taken off, the letters were left raised as if they had been cut out with the chisel. The work was done so fast that three hundred headstones were made in a day, or as many as three hundred men could have done in the same time, working with the hammer and chisel.

The word sand is Anglo-Saxon.

SANDAL-WOOD, the wood of a tree that grows in India and China. It is quite heavy, has a fine grain, and a sweet perfume and spicy taste. The Chinese use a great deal of it for making small boxes and other cabinet work and toys, and for the frames of fans. They also burn it as incense in their temples. In the East Indies it is used instead of boxwood for wood engraving. It is good for making cabinets for preserved insects, because live insects do not like the smell of it. The roots, chips, and sawdust of sandal-wood are made into sandal-wood oil, which is used in perfumery. Red sandal-wood, sometimes called sanders wood, is of a deep red and takes a fine polish. It is used mostly as a dye-stuff, and for coloring the red spirits of lavender, bitters, and other things.

The word sandal is from the Arabic *çandal*, Persian *sandal*, sandal-wood.

SAND-PAPER. Paper covered on one side with fine grit, used for smoothing wood, bone, ivory, metals, and other things. It is made by smearing stiff brown paper with glue and sifting sand upon it while wet. About six different sizes of sand are used to make sand-paper of different fineness. A kind of sand-paper called glass-paper is made by grinding up broken wine-bottles, and using the siftings in the same way as sand. Sometimes flint burnt and ground fine is used also. Emery paper is made in the same way.

The word sand-paper is made up of the Anglo-Saxon *sand*, and paper, which is from the Latin *papyrus*, paper.

SAND-PIPER, a small bird of the snipe family, living in flocks on the seashore or on the borders of lakes and rivers. They have long legs and long bills with which they probe the sand and mud in search of worms and small crustaceans. Among the American kinds are the purple sand-piper, called by gunners rock-snipe, found in the Eastern and Middle States and on the Great Lakes; the red-backed sand-piper, along the Atlantic coast; the American green, north to Alaska; and the least, or peep, all over the cooler parts of North America.

The sand-piper belongs to the order *grallatores*, or wading birds. The sand-piper is so called from its piping note as it runs along the sands.

SANDSTONE, a kind of rock formed of grains of sand, cemented together by carbonate of LIME, oxide of IRON, silica (see SILICON), or clay. Fine-grained sandstone is used for building, and coarse-grained for millstones. Coarse sandstones sometimes have pebbles in them, and are then called pudding-stones. Some sandstones are very lasting, while others wear out very soon when exposed to the weather; the cement by

which the grains of sand are held together being loosened by air and moisture, the stone falls to pieces. The sandstone used in this country for building is brought mostly from Ohio, Pennsylvania, Colorado, and Connecticut; but New York, Massachusetts, New Jersey, Michigan, New Mexico, Wisconsin, California, and Missouri also furnish a good deal, and it is found in many other States. Berea sandstone comes from Berea, Ohio; buff Amherst and blue Amherst from Amherst, Ohio; brownstone from Portland, Connecticut, and Little Falls, New Jersey; Peachblow sandstone from Peachblow, Colorado; Potsdam sandstone from Potsdam, New York, and Nyack sandstone from Nyack, New York. Nova Scotia stone is yellowish brown; it is much used in New York for house fronts. A light yellow sandstone, brought from Caen, in France, is sometimes used in this country, and makes a very handsome building stone.

The word sandstone is made up of the Anglo-Saxon *sand* and *stan*, stone.

SAPODILLA, the fruit of a tree which first grew in tropical America. The tree, called the sapota, has been transplanted to other warm countries and is now cultivated in the Mauritius, the Malay Archipelago, and India. The fruit, like a small plum, is at first a little sharp in taste, but when over-ripe becomes sugary and pleasant, and has a delicious perfume.

The word is from the Spanish *sapotilla*, diminutive of *sapota*, from the Mexican *zapotl*, the sapota tree.

SAPPHIRE, a PRECIOUS STONE, next to the diamond in hardness. What is commonly called the sapphire is a beautiful purplish-blue stone, which is next to the ruby in value, but there are really sapphires of several different colors. They are all made up of the same thing, alumina (see ALUMINUM), but colored in different ways. The red sapphire is properly called the oriental RUBY, the green sapphire the oriental EMERALD, the yellow the oriental TOPAZ, and the violet the oriental AMETHYST. The word oriental used in this way does not refer to the East, but only means something very fine. Colorless sapphires are sometimes found, and are set and sold for diamonds, but they are not so bright as diamonds. They are called white sapphires. The finest blue sapphires come from Ceylon, but some are brought from India and Persia, and a few from Russia.

The word sapphire is from the Latin *sapphirus*, Hebrew *sappir*, sapphire.

SARDINE, the common name of the young of a fish of the herring family, which, when it grows up, is called the pilchard. It is an elegant little fish, with a slim, graceful body three to four inches long, greenish-blue on the back and silvery-white below. Sardines are found in the Mediterranean, the North Atlantic, and the Baltic. A large part of those which are sold are caught off the coast of Brittany, France. Early in spring these little fish appear in large shoals, often so closely packed together that many are shoved out of the water, and they keep on coming all summer long. They are caught with nets, the meshes of which are just large enough to let through the head of the fish, which is thus caught by the gills or fins.

When a shoal is seen, the boats put off from shore and the nets are cast. The nets are very long, and are fitted with floats of cork at the top and lead sinkers at the bottom, so that when one is put into the water it stands up straight and forms a kind of long wall, reaching from the top of the water down very deep. It is set in a curve, and bait is thrown overboard. The sardines rush in to get the bait, and get their heads caught in the net. As soon as one net is full another one is set, and the first is hauled in. The boats are loaded and the fish taken ashore,

where they are at once washed, scraped, and salted, their heads and gills cut off, and then washed again and dried in the sun on frames along the shore. When dry they are cooked in great kettles of boiling olive oil for two hours, and dried again, when they are ready for packing in the tin cases in which we usually see them. This is done by women, who fit them into the boxes, pour boiling oil over them, fit on the lid, and seal it.

Sometimes sprats, shiners, roach, and dace are put up in the same way and sold for real sardines. A large part of all those called sardines which are sent to the United States are these fish. In the United States the menhaden is called the American sardine. It is caught on the New Jersey coast, put up in oil, and sent to Europe in large quantities.

The sardine is from the Latin *sardina*, Greek *sardene*, sardine, from Greek *Sardo*, Sardinia, off the shores of which many of these fish are caught.

SARDONYX. See AGATE.

SARSAPARILLA, the dried roots of several kinds of climbing evergreen plants, which grow in Mexico and Central and South America. The roots are reddish-brown, about as large as a goose quill, and nine or ten feet long. Sarsaparilla is much used as a medicine, especially in rheumatic and skin diseases. The patent medicines called sarsaparillas, and the syrup drunk in soda, have none of this drug in them.

The word sarsaparilla is from the the Spanish *zarzaparilla*, thorny-vine, from *zarza*, thorn, and *parilla*, diminutive of *parra*, a vine.

SASSAFRAS, a tree of the same family with the laurel, growing only in North America. In the Northern States it is little more than a bush. but in the Southern States it grows as high as a high house (50 feet). The tree is very fragrant, but its scent is not liked by insects, and trunks and drawers made from its wood are therefore good to keep furs and woollen things in. The bark of the roots has a sharp sweetish taste. A kind of tea is made from it, which is used as a domestic medicine, and is thought to purify the blood. The dried root is sold in drug stores, and is given in cases of rheumatism and skin diseases. Sassafras oil is made from the roots by distillation (see ALCOHOL).

The word sassafras is said to be from the Spanish *salsafras*.

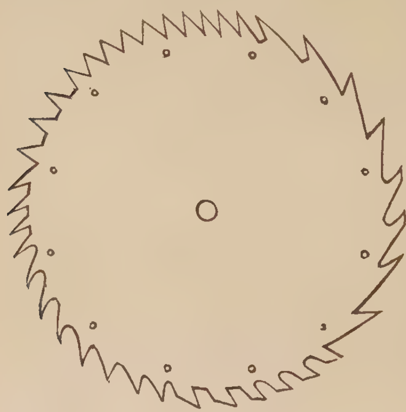
SATURN, one of the planets of the solar system (see UNIVERSE). It is the furthest from the sun of the planets known to the ancients, and only Uranus and Neptune are beyond it. It is nine and a half times as far away from the sun as the earth, or about 872,000,000 miles. Its diameter is 70,500 miles, or nearly nine times that of the earth, so that it is about 700 times as large as the earth. It revolves on its axis in 10 hours and 14 minutes, or less than half a day, and takes 29 years and 167 days to go round the sun. Saturn is the most remarkable of the planets, being the centre of a system of its own, unlike any other in the heavens. It is surrounded by two rings, one within the other, supposed to be made up of a countless number of little satellites or moons, each revolving by itself. Though many thousand miles broad, Saturn's ring is less than a hundred miles thick, so that when the edge is toward one, it looks like only a line of light. Saturn has eight moons of different sizes, moving round it in orbits outside the ring. The largest one is about the size of the planet Mercury.

Although the ancients had observed Saturn they did not know it had a ring. Galileo thought it had a little planet fastened on each side of it, and called it tri-corporate (three-bodied). In 1655 Huyghens announced that it was a ring, and in 1665 Ball of England found out that it was two rings. In 1850 G. P.

Bond, of Cambridge, Massachusetts, found a third dusky ring inside the other two.

Saturn was named after the old god Saturn.

SAW. Saws differ in shape, size, and in the form of their teeth, according to the kind of work for which they are made. The chief kinds in common use are the hand saw, of which there are many varieties, all of which are used by one hand; the cross-cutting saw, with a handle at each end, which is worked by two men and is used for cutting timber crosswise; and the circular saw, which is always worked by machinery.



Circular Saw.

A good saw ought to be of equal thickness in the blade, and so elastic or springy that when bent into a bow it will spring back into shape again. Great care therefore has to be taken in its manufacture. The blade is cut with large shears (see SCISSORS) out of a sheet of steel made by rolling out an ingot or heavy bar of cast steel. After the edges have been ground smooth on a grindstone, the teeth are made by cutting out small pieces with a punch worked by machinery, the blade being shifted one tooth forward at a time until the whole row is cut. The teeth are then sharpened by filing off the rough edges, and the blade is tempered or hardened by heating it red-hot and plunging it into a mixture of oil, tallow, and resin, after which it is planished, or made smooth and even, by hammering with a smooth-faced hammer on an anvil of polished steel. It is then ground so that it shall be a little thinner at the back than on the edge, and next set. Setting consists in bending the teeth by striking them with a narrow hammer so that half of them shall turn to one side and half to the other side. This makes the cut of the saw a little wider than the blade, and prevents its being choked with saw-dust. The handle, which is usually of beech wood, is then put on, and the saw is finished by cleaning with EMERY.

Circular saws are now much used in saw mills, as they work faster than straight saws. They are made to turn very fast in a slit through a table or bench, and the wood to be cut is pushed up against them. In those for sawing hard wood the teeth are made much smaller than in those for sawing soft wood. The teeth are made of many different shapes, as in the picture, where to save space several kinds are put on to one saw, a different kind of tooth being shown between each of the little holes around the edge; but in real saws each one has only one kind of teeth. Saws are made also with movable teeth, so that a new one can be put on when one is broken, or all can be taken off to be sharpened.

The word saw is from the Anglo-Saxon *saga*, saw, from Latin *secare*, to cut.

SCALES. The word scale once meant the pan of a balance, but now the name is used for the balance itself. In this article it is given to any kind of weighing machine,

The simplest and probably the oldest kind is the common even balance scale, which has a beam with arms of the same length, from the ends of which are hung the scale pans. The beam is sometimes hung up by a

Fig. 1.—Scale for Weighing Gold.

hook in the middle, as shown in Fig. 1, which is a small hand scale used in weighing gold; or held up by a post, as in Fig. 2, which shows a scale used by apothecaries in weighing medicines, and by chemists in weighing different substances. As the greatest of care has to be taken in such weighing, these scales are kept shut up in a glass case, as shown in the picture, to keep them free from dust. Some of them are so delicate that the air which is moving in a room, and even the heat from a person's body, will cause the

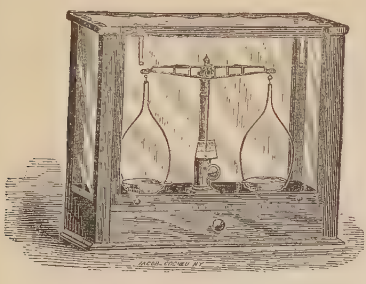


Fig. 2.—Apothecaries' Scale.

beam to move. When anything is to be weighed in them, the doors of the case are opened, the thing to be weighed and the right weights put into the pans, and the doors then closed again. Thus the air of the room and the heat of the person weighing is shut off from the scale, and the beam can be more evenly balanced.

Another kind of even balance scale is shown in Fig. 3. This scale, which is much used by grocers, is the same in principle as Figs. 1 and 2, the only difference being that the pans are placed above the beam instead of being hung below it.

The steelyard is another very old form of weighing machine, having been in use by the ancient Romans, who called it *statera*. It differs from the even balance scale in having one arm of the beam short and the other long. In the even balance scale a weight equal to the thing to be weighed has to be put into the other pan. For instance, if a thing of

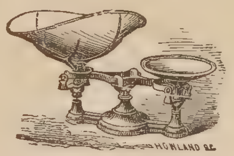


Fig. 3.—Grocers' Even Balance Scale.

ten pounds is to be weighed, it must be balanced by ten pounds of weights. In weighing heavy things this was found to be very inconvenient, so the beam was made with one long and one short arm, the thing to be weighed being hung on the short arm and the weight on the long one. A very much lighter weight is thus needed to balance the thing weighed, and the further the weight is pushed along toward the end of the long arm the greater weight it will balance. The steelyard is not so good as the even balance scale for weighing small things, but it is very useful for weighing heavy things. Still, very small ones are sometimes used. The one shown in the picture, Fig. 4, is called a grain tester, which tells how many pounds a bushel of any kind of grain will weigh. The cup, which in some of these testers holds only a half pint, is filled with grain, and

the little weight on the beam is then pushed along until the cup is balanced; and the figures on the beam where the weight stops show the number of pounds of the grain in a bushel. In Fig. 5 is shown a larger kind of steelyard, used for weighing bales of cotton. This kind of steelyard is called a weighers' beam. It is not exactly like the old steelyard, but the principle is the same. When a bale of cotton is to be weighed, the iron handle, on the top of the frame, which looks like a pump handle, is unhooked from the

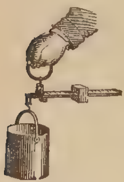


Fig. 4.
Grain Tester.

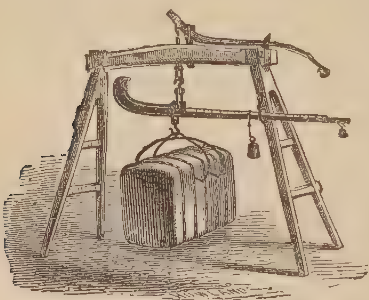


Fig. 5.—Weighers' Beam.

little catch seen near its middle. This lets the beam down far enough to catch the four hooks into the sides of the bale, and the handle is then pushed down and hooked in the catch again. By this means the cotton bale is raised up from the ground. It is then weighed by pushing the weight along the beam until it balances, and the figures on the beam where the weight stops shows the weight of the bale.

It will be seen that this weighers' beam has two weights on it, one large one and one small one. This is because the beam has two sets of figures, one on one side and one on the other side of the beam. In weighing light things the small weight is used on the one side of the beam, and in weighing heavy things

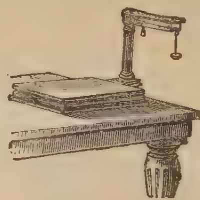


Fig. 6.—Counter Platform Scale.

the large weight is used on the other side. The steelyard has but one weight, and the two sets of figures are on the top and bottom of the beam, and when a heavy thing is to be weighed the beam has to be turned over so as to bring the large set of figures on top.

Platform scales are usually made, like steelyards, with a beam with arms of unequal length, so that the principle of the two is the same. The chief difference between them is that in the platform scale the thing weighed, instead of being hung under the beam, as in the steelyard, is put on a platform which is joined by an iron rod to the short end of the beam, so that when the platform is pressed down the beam is pulled down. Some platform scales are made small enough to stand on a

Fig. 7.—Platform Scale.

counter or table, like the one in Fig. 6, and some are large enough to weigh a load of coal or hay, a rail-

road car filled with freight, or even a drove of cattle. In the picture, Fig. 7, a load of hay is being weighed on a platform scale. Two weights are used in weighing heavy things on these scales. The weights hung on the end of the beam mark the hundreds, and the one which slides along on the beam marks the parts of a hundred. For instance, if the load of hay weighs 2050 pounds, weights for 2000 pounds will be hung on the end of the beam, and the sliding weight will be pushed along until it comes to 50, when the beam will exactly balance.

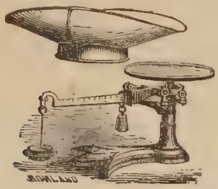


Fig. 8.—Druggists' Counter Scale.

Small scales made on the same principle as the platform scale, but having the pan or platform for the thing weighed above instead of below the beam, are much used by grocers, druggists, etc., on counters. One of these is shown in Fig. 8. The letter balance, used for weighing letters, shown in Fig. 9, is made on the same principle.

The spring balance, another kind of scale on a different principle, is much used by butchers. The spring is made of a wire coiled up. The top of the wire is fastened to the top of a rod, which is so made that when the rod is pulled down a pointer is made to turn round a disk like a clock face, on which are figures and marks showing the pounds and parts of a pound. The one shown in the picture will weigh anything up to twenty pounds' weight. At the bottom of the rod is a hook, on which is hung a pan for the things to be weighed. In some spring balances the pointer moves up and down in a slit in the face, and the figures are marked on it in much the same way as on the scale of a thermometer.

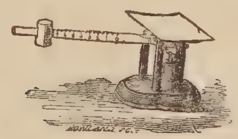


Fig. 9.—Letter Balance.

The word scale is from the Anglo-Saxon *scale*, the dish of a balance. Balance is made up of the Latin *bis*, twice, and *lanx*, plate, so that it means a pair of scales. Steelyard is a changed form of *staple-yard*, that is, the yard or beam used at the staple. In England, in old times, the king's staple or market was set up in certain towns, and certain kinds of goods could not be sent out of the country until they had been first brought to these places and charged the duties payable to the king. Such goods were called staple goods, because they were brought to the king's staple, and the beam with which they were weighed was called a stapleyard.

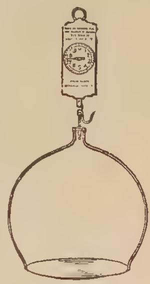


Fig. 10.
Spring Balance.

SCALLOP, a kind of shell-fish, having a nearly round ribbed shell with scalloped edges. The shell is very light and the fish has inside a little air bag which enables it to float. It can move also by opening and shutting its shell. The scallop is found along the coast of New England, New York, and New Jersey, and is much used for food. The chief fisheries are in Buzzard's Bay, Narragansett Bay, and Peconic Bay at the east end of Long Island. Scallops are caught from sail boats, by dragging hand dredges with an

iron blade which scrapes them up from the bottom. Only the hard muscular part which holds the shells together is eaten. The soft slimy rim is sold for manure, and the shells to oyster planters, who spread them over oyster beds for young oysters to fasten to. The shells can also be made into pretty pin-cushions and ornaments for frames, boxes, etc.

The scallop abounds on the coast of Palestine, and in old times pilgrims returning from the Holy Land used to wear them to show that they had been there. A scallop found off the coast of England has a large shell, which was much used formerly for cooking oysters in; and from this the dish has ever since been called scalloped oysters.

The word scallop was formerly spelled escalop, and is from the Old French *escalope*, scallop.

SCISSORS and **SHEARS.** Scissors are made up of three parts, the blades, the bows, or rings to put the fingers in, and the shanks, or parts between the blades and the bows. The best scissors are made of cast STEEL, but some are made of shear steel, some partly of steel and partly of iron, and some of common cast-IRON. The kinds most in use are made of shear steel, and have only the blades hardened. Large scissors, such as tailors' shears, have the blades only of steel, the bows and the shank being made of iron. Only the cheapest scissors are made of cast-iron.

Scissors blades are forged in much the same way as KNIFE blades. One blade is made at a time, and enough of the metal is cut off with it to form the shank and the bow. A hole is then punched through this metal large enough to let in the point of a small anvil, upon which the bow is hammered into shape. The parts are then shaped better by filing, and the hole for the rivet is bored. The blades are next ground, and the bows and other parts are polished with EMERY and oil. The blades are then fitted together, the screw is put in, and the parts are made to work smoothly. The two parts are next bound round with fine iron wire, the screw is taken out, and the blades and shanks are hardened by heating them and cooling them quickly in water. After the wire is taken off the blades are ground again, fastened together, and made to work right, and lastly polished and finished.

Fig. 1.—Shears for Cutting Sheet Metal.

A great many different kinds of scissors are made, such as cutting-out scissors, button-hole scissors, and other kinds used by women; scissors for cutting paper, hair, lace, and the nails; for trimming flowers, grape-vines, and other shrubbery; for trimming horses and shearing sheep; and scissors and shears for the use of tailors, stationers, bankers, barbers, book-binders, tinsmiths, iron-workers, etc. The shears used for cutting tin, sheet iron, sheet copper, and other sheet metals are made with very strong blades, one of which is fixed tight, so that the upper handle may be used with both hands. A picture of one of these is given in Fig. 1. In this, A is the part fastened to the workman's bench, and B is the part which is moved; so this kind of shears has but one handle.

A still stronger kind, used for cutting bars of iron one to two inches thick, is shown in Fig. 2. In this the two blades, marked *a* and *b*, are of iron and have steel edges fastened on to them with bolts. The

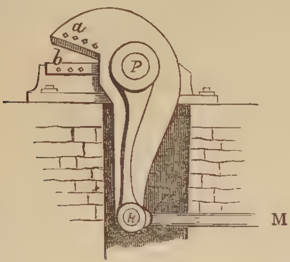


Fig. 2.—Shears for Cutting Bar Iron.

lower blade is fixed, and the upper one moves on a pivot at P. The handle of the shears runs down to R, and is there fastened to a rod M, which is worked by the steam-engine which moves the other machinery. Every time the axle of the engine turns round, the rod M moves backward and forward, thus opening and shutting the jaws of the shears.

Another kind of shears works with a spring, which keeps the blades always open. All the workman has to do is to close the blades together

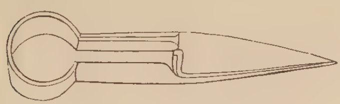


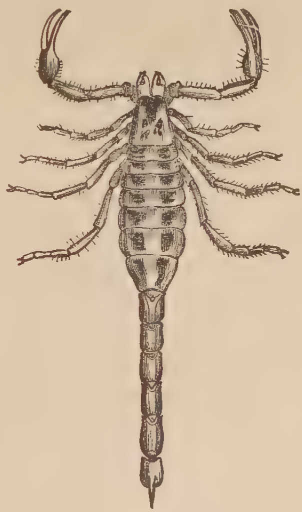
Fig. 3.—Sheep Shears.

by shutting his hand, and every times he opens his hand the blades spring open again. One of this kind is shown in Fig. 3, in which the round part is the spring. Such shears are used for shearing sheep, clipping horses, etc.

The blades of scissors and shears are not like knife blades, which are sharpened on both sides, but like chisels, which are sharpened on but one side; so scissors are really double chisels, the blades of which are made to move toward each other and cut whatever comes between them. In some machines the two blades are made round like wheels, which move toward each other, so that the edges shut close together and cut whatever is pushed against them. This makes an endless pair of scissors, for the blades never cease shutting together while the machine is working. Such shears are used by paper makers and other manufacturers.

The word scissors is from the Old English *sisoures*, which is from the Latin *scindere*, *scissum*, to cut. Shears is from the Anglo-Saxon *sceran*, to cut off, to divide.

SCORPION, an animal of the spider family, having a tail about as long as its body, ending in a sharp



Carolina Scorpion.

sting, from which is discharged a whitish poisonous fluid. Scorpions live in warm climates, where they frequent dark places, hiding under stones and logs, in old stumps, or in ruined houses. They run very fast,

keeping the tail up. They feed chiefly on insects, especially crickets, and will even eat small lizards. They catch their prey and sting it to death, and then suck the blood. Their sting is very painful to human beings, but not fatal. In India and Ceylon scorpions grow sometimes five or six inches long, but the common brown scorpion of Southern Europe is only about an inch long. There are several kinds in the Southern United States from South Carolina to Texas, and some in Southern California. Chickens are very fond of scorpions and eat all they can catch.

The scorpion belongs, with the spiders, to the second class of articulate ANIMALS.

The word scorpion is from the Latin *scorpio*, Greek *skorpios*, scorpion.

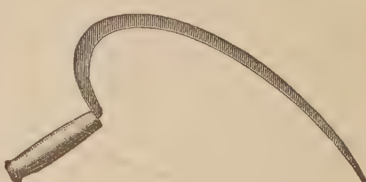
SCREW. The common screw, used instead of nails to fasten pieces of wood together, consists of a head with a slit across it for the screw-driver, and a long part, the upper end of which, called the shank, is round and smooth, and the lower end, called the thread, which is cut round in a spiral, tapers slightly toward the point. In old times screws were made wholly by hand, but now they are made much faster and better by machines. Round wire of the proper size is drawn from a reel, in much the same way as in the PIN machine, a piece of the right length is cut off, and the head is made on it by several blows from a DIE or punch. The blank thus formed next drops into a box, in which it is carried to another machine to have the slit made in the head. This machine has in it a wheel without a rim, that is, with spokes only, each of which is forked at the end. As the wheel turns round, each spoke picks up one of the screw blanks by the head and carries it past a small circular saw which in a moment cuts the slit for the screw-driver. The blanks are then put into a LATHE-chuck, one by one, and made to move to and fro, while a fixed tool cuts the thread evenly and smoothly. Thus all the workmen have to do is to see that the machines are properly fed with the blanks. One of the most valuable of the modern improvements in screws is the making of them with sharp points, like the point of a gimlet, which causes them to enter the wood much more easily than the old style of screw. All the best machines for screw-making are American inventions.

The word screw is from the Old English *scrue*, Old French *escroue*, screw.

SCUP or **SCUPPAUG,** a salt water fish, often called porgy. The common scup is caught from Massachusetts to Georgia. It is a broad fish, usually less than a foot long, and is a dusky pink above and silvery below. It is easily caught with hook and line, clam bait being generally used, and is very good eating when fresh.

The word scup is shortened from the Indian *mishcup*, large-scaled; and scuppaug, from *mishcuppaûog*, the plural of *mishcup*.

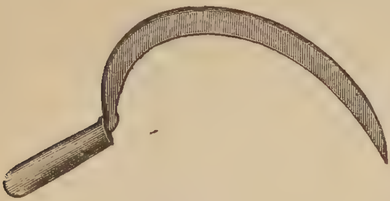
SCYTHE, an instrument for cutting grass, grain, bushes, and weeds. The scythe is a kind of large sickle, a tool which was probably in use before the scythe. Both instruments



Sickle.

were known to the Romans, who used them not only as farmers' tools, but also as weapons of war. The ancient sickle was like that now in use, but the scythe had a straight handle instead of a crooked one.

The **Sickle** is not used in this country, grain being usually cut here with either the cradle or the reaping machine, but it is still used in Great Britain and in other parts of Europe. Its form can be seen in the picture, where the edge is shown smooth; but in some sickles the



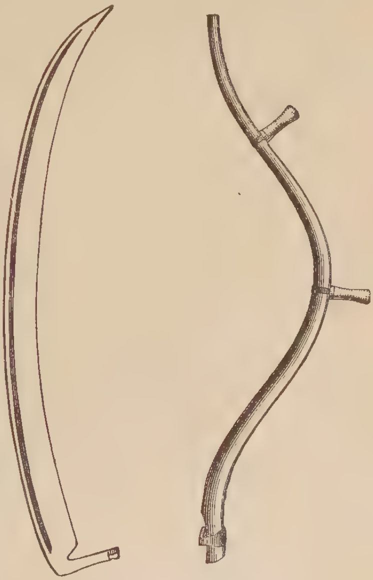
Grass Hook.

edge is made toothed like a saw. In reaping, the harvester takes as much of the grain as he can hold in the left hand, and then cuts off the stalks as close to the ground as possible with the sickle. The handfuls are laid as fast as cut on a band made of some of the straws twisted together, and when enough are thus collected they are tied up in the band and made into a sheaf, like that in the picture. In the United States a kind of sickle called a grass hook is used for trimming grass borders and parts of lawns where scythes and lawn mowers cannot be used.

Sheaf.

The **Scythe** is used mostly for cutting grass, especially on small farms where it would not pay to buy a mowing machine. The grass scythe has a long slender blade, which is slightly curved as in the picture. Scythe blades are forged under a trip-HAMMER, and then ground into a good shape on grindstones. The handle, called in New England a snath and in England a sned or helve, is made of wood, bent as in the picture, and has two handles. Scythes with short stout blades, called bill hooks or bush scythes, are used by farmers for cutting down bushes, brambles, and rank weeds. On most large farms mowing machines drawn by horses, which cut grass very fast, are now used. The best kinds of these, as well as of reaping machines, were first made in this country, and are largely used all over the world. Lawn mowers, for clipping closely the grass of lawns, are made to be drawn by horses or to be used by hand; the hand machines, which are small and light, being used mostly for trimming the grass in dooryards.

Cradles are scythes for cutting grain: they have above the blade a framework of wooden bars which catches the grain when it falls and



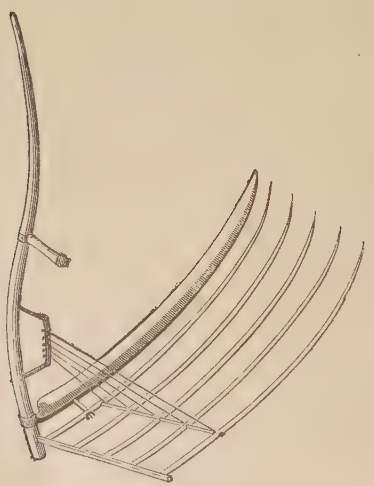
Grass Scythe and Snath.

lays it straight so that it may easily be gathered into a sheaf or bundle. The snath and the blade are like

those of the grass scythe, only the blade is a little broader and heavier.

Turkey-wing Cradle.

The pictures show two kinds of cradles. The one called the turkey-wing cradle is used in the Northern



Southern Cradle.

States for cutting grain. The Southern cradle, which is heavier and stronger, is used in the Southern States, mostly for cutting rice.

The word scythe is from the Anglo-Saxon *sithe* or *sigthe*, scythe. Sickle is from the Anglo-Saxon *sicol*, Latin *secula*, sickle, which is from *secare*, to cut.

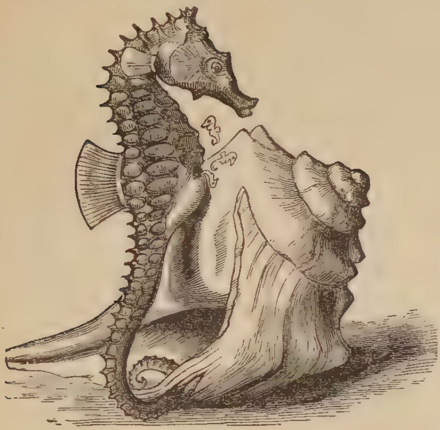
SEA-ELEPHANT, a large kind of seal, called also bottle-nosed seal and seal elephant. It is the largest of the seal family, being larger than an elephant. The average length of the male is 12 to 14 feet, but some of 20 and 25 feet are mentioned. The female is generally about 10 feet long. It gets its common name from its size and also from its proboscis, which stretches out a foot or more, somewhat like the trunk of an elephant. The males are slaty-blue or brown, the female olive-brown above and yellowish below. Their hair is coarse and useless, but their thick skin makes good harness leather. The blubber yields a fine clear oil as good as sperm oil, without bad smell or taste. In England it is used for softening wool and in making cloth.

The sea-elephant was once found in abundance at Heard's Island in the Southern Indian Ocean, and at the Falkland and South Shetland Islands and other islands in the South Atlantic, and thousands of barrels of oil were brought from there every year, but the elephants were hunted so persistently that few are now left. It was once common, too, on the coast of California, but is now seldom seen.

The sea-elephant is a mammal of the order *carnivora* or flesh-eating animals.

SEA-HORSE, a small bony fish with a head much like that of a horse. The kinds found on the Atlantic coast are only 3 to 6 inches long, but a California species is often 8 to 10 inches long. The sea-horse of the Atlantic coast is ashen gray speckled with tiny spangles that shine like silver. Its body is covered with plates like a coat of mail, extending to the end of its long tail. It uses

its tail like a monkey, winding it around any object to rest when it gets tired of swimming. It always



Sea Horse Beside a Shell.

swims erect, carrying its head with the neck curved like a proud horse, looking around with its queer little golden eyes, which are independent of each other, gazing two ways at once. The male sea-horse has under it a sac-like pouch, in which the female lays her eggs, and the male carries them until they are hatched, the female giving them no further care. Sea-horses are very interesting inmates of aquaria, and dried specimens are often sold in curiosity shops in seaside towns.

SEAL. The seal family includes the WALRUS, the SEA-ELEPHANT, the SEA-LION, the hair seal, and the fur seal. The hair seal has coarse, hard, stiff hair, without any soft under fur; the fur seal has a soft, plush-like under fur, which gives the skins of the females and younger males great value. Hair seals are yellowish or reddish brown; fur seals are black when young, but grow lighter with age until they become yellowish or whitish gray.

The body of the seal is long and slender, and tapering toward the tail. It has a small head, somewhat like a dog's with the ears cut off, strong whiskers like those of a cat, and large, soft, sad eyes. The front limbs are very short, so that the paws are near the body; the hinder limbs are turned backward on each side of the tail. All the paws are like paddles, being covered with a skin which stretches between the fingers. The seal swims mostly by the aid of the hinder limbs, which are worked like sculls, the front ones being used only to turn about with. It can swim very fast and is skilful in diving, being able to stay under water fifteen to twenty minutes; but it moves very awkwardly on land, making short, jerky leaps, and dragging the hinder limbs along.

Seals like to bask in the sun upon rocks, sand banks, or ice-floes, always keeping a good lookout for danger. They can see far, and their sense of smell is very sharp. They live mostly on MOLLUSKS, crabs, and fish. In the winter they make holes in the ice, where they can come up to breathe. Sometimes one comes out to eat a fish, as shown in the picture. The Esquimau watches near seal holes until one is seen coming up; then crawls softly along on the ice, making a cry like a seal, and the poor animal, who takes it for another seal, does not discover its mistake until it gets a deadly blow.

Harbor Seal. This seal, so named because it is seldom seen far from shore, is called also the sea-dog. It used to be common all along the north Atlantic coast, as far south as North Carolina. Robin's Reef in New York harbor got its name from the seals that used to be plentiful there, robin or robyn being the Dutch name for seal. Harbor seals are frequently seen now on Execution Rock in Long Island Sound, in the

Connecticut River, and even in the Hudson River. They are common in summer along the Newfoundland coast and in the Gulf of St. Lawrence, and it is said they sometimes go up the St. Lawrence into Lake Ontario and even into Lake Champlain. The harbor seal is generally four to six feet long, and its fur is yellowish brown above and whitish below, sometimes pied and marbled. Its skin was once much used for covering trunks; it is now made into coats, caps, and gloves. In Greenland it is prized as material for women's breeches, and no more acceptable present could be given an Esquimau girl.

Harp Seal. This seal, which is a hair seal and not a fur seal, varies in color with its age. When young it is white and woolly, but with age the males become grayish white with a dark stripe on each side from the shoulders to the tail, called a harp or saddle. The females are rusty gray about the head and white under the throat. Harp seals are found from Newfoundland to Greenland. Many are taken along the shores and on ice floes. During the sealing season in spring hundreds of vessels with thousands of men pursue the seals, shooting the old ones and killing the young ones with clubs. As many as a million are captured every season, some vessels taking more than two thousand in a day.

Seal Eating a Fish.

Harp seals are very useful to the Greenlanders, who eat their flesh, and use their oil for light, warmth, and cooking; their skins for clothes, boots, and tent-coverings; their sinews for thread and fish-lines; the skins of the entrails for window curtains and shirts; and their blood for making soup. The skins of commerce are mostly sent to England, where they are made into a superior kind of patent leather.

Fur Seal. This seal, called also sea-bear, is found in almost countless numbers on the Pribylov or Fur Seal Islands, off the coast of Alaska. It does not go much farther north and is not found in Bering Strait. This makes these islands, where the seals go in millions every year to breed, very valuable.

The male of the fur seal, when full grown, is from six to seven feet long and will weigh 400 to 500 pounds; the female is about four feet long and weighs 80 to 100 pounds. The neck, chest, and shoulders of the male make more than two-thirds of his whole weight. The body is covered with two coats, like the down and feathers on the breast of a duck; the under one a soft fur, which gives the skin its value, and the outer one

a short brownish, glistening over-hair, darker on the neck and shoulders and grayish on the sides. On the sealing grounds, called "rookeries" by the sailors, the males are called bulls, the females cows, and the young ones pups. The pups are jet black for the first three months, with a white patch on each side. While the sea-lion makes only a hoarse roar, the fur seal bull has four calls or notes: a long loud roar, a low growl, a piping kind of whistle, and a choo-choo-choo sound like escaping steam from a locomotive. The cows have only a bleating call to their pups so much like the cry of an old sheep as to attract sheep. When tens of thousands of seals are collected on the breeding grounds making all these noises, the sounds can be heard five or six miles at sea.

The Pribylov Islands were discovered in 1786 by a Russian named Gehrman Pribylov, who commanded a sloop called the St. George. They lie in the middle of Bering Sea, about 200 miles west of the mainland, and being shut in most of the time by fog-banks, gave the seals a happy home until the white man found them out. The islands most frequented by seals are St. Paul and St. George, the latter about thirty miles south-east of the former. They go also to Bering and Copper Islands, 700 miles westward on the Russian side, but to no others. The animals like these four islands best because the shores are well fitted for them to land on when they come from the sea in the spring, and have firm well-drained ground for their rookeries. These are now the only seal islands of importance in the world, the Falkland Islands and all others in the southern seas, excepting a small rookery near the mouth of the Rio de la Plata, having been stript of seals. These islands are therefore very valuable, and this is the reason why our government has taken so great pains to protect the seals against Canadian fishermen.

Only 100,000 seals are allowed by law to be killed each season (May and June), and as there are more than four million on the islands this number can safely be taken. Early in the morning, men go down to the rookeries and get between the sleeping seals and the sea. When the seals see men between them and the water, they scramble back over the land, and are thus driven by thousands at the rate of half a mile an hour, to the killing grounds near the village. Here they are knocked on the head with hickory clubs made for the purpose in New London, Connecticut, and then skinned. The skins are carried to the salt-house and salted in piles; after lying thus two or three weeks they become pickled, and are rolled up by twos, with the fur side out, in bundles and shipped. In this condition the skins are not at all handsome, the fur being entirely hidden under the stiff, grizzled over-hair. They are all sent to London, where the outer hair is removed and the skins are dressed and dyed and come back to us of the beautiful seal brown color we know so well.

The natives eat the flesh of the fur seal; but it must be cleaned of every particle of fat, which is very strong, to make it edible to a white man. The blubber is made into oil, but it is very offensive to the smell, and is not worth as much as hair seal or sea-elephant oil. The carcasses are generally left to rot on the islands.

The seal is a MAMMAL of the order *carnivora*, or flesh-eating animals.

The word seal is from the Anglo-Saxon *seol*, seal.

SEALING-WAX. This was formerly much used for sealing letters, but as letters sealed with it are apt to stick together in warm countries, gummed envelopes have now almost taken its place. It is still used to some extent in fixing seals to legal and state papers, the seal being

pressed on the wax when hot. Sealing-wax is made of LAC mixed with a little turpentine and resin and some coloring matter. Red sealing-wax is colored with vermilion, and black with ivory black. Golden sealing-wax has powdered yellow MICA mixed with the lac. Sealing-wax was first made in India, and was not known in Europe until about two hundred years ago.

The word sealing-wax is made up of seal, from the Anglo-Saxon *sigel*, Latin *sigillum*, a seal or stamp, and wax, from the Anglo-Saxon *weax*, wax.

SEA-LION, a large kind of seal found in the south seas and on the Pacific coast of America. It is abundant on the coasts of California and Alaska. The head of the sea-lion is larger than that of the seal and has a lion-like look, with a mane of erect hair and heavy eyebrows and long whiskers. It is generally tawny red, and the males, which are twice as large as the females, are sometimes fifteen feet long and weigh 1600 pounds. The sea-lion leaves the water during the breeding season and passes several weeks on land in chosen places called by seal hunters "rookeries." The voice of the California sea-lion is a "honking" bark or howl, but that of the Alaskan animal is a deep bass roar, which has been compared to the sound of a tempest howling through the rigging of a ship. The sea-lion lives on fish, MOLLUSKS, CRUSTACEANS, and sea fowl. As a full grown one will eat forty pounds of fish in a day, these animals are very injurious to the fisheries. There are said to be 25,000 of them in and around the bay of San Francisco. Near the city of San Francisco, not far from a hotel on the shore, is a rock called Seal Rock, where the sea-lions sport all day long, to the amusement of people who watch them from the hotel piazza. They are not at all afraid, for they are protected by law and no one is permitted to disturb them. In warm summer days they may be seen climbing up the rocks and sliding down again into the water, barking as if they enjoyed it.

In Alaska the sea-lion is hunted for its oil and skin, which is good for making glue. The whiskers and the livers are sent to China, the former to be used for cleaning opium pipes and the latter to be chopped up and made into medicine. The Indians prize the sea-lion for its flesh, skin, and other parts, all of which are of use to them. The flesh of the cubs is said to be tender and juicy, and much like veal.

The sea-lion is a MAMMAL of the order *carnivora*, or flesh-eating animals.

SEASONS. See EARTH.

SEAWEED, any plant growing wholly in water, fresh or salt. Some are found only in fresh water, some only in salt, and some in both. Some are so small and delicate that they can be seen only with a MICROSCOPE, and others are of such immense growths that they almost fill up the seas in which they live. The great seaweeds called sea aprons are often several hundred feet long.

Seaweeds are not much like the PLANTS that grow on land. They have no roots and therefore do not get any of their food from the earth, but live entirely from the water. Many float around in the water and many are fastened to rocks and other things at the bottom of the sea, to which they are made fast by a kind of stem with a sticky surface. They have no real leaves, but have parts which answer for leaves. Sometimes these are like wavy thongs, sometimes like crumpled threads; others are like fans, balloons, leather belts, delicate ribbons, or shreds of jelly. Some are thick and tough, others thin and tender; and they are of many colors, such as fawn, yellow, brown, olive, green, pink, and carmine. Those in deep waters are mostly brown of different shades, and those nearer the sur-

face and often floating are mostly green; the pinks and reds are found chiefly in shallow water near the shore.

In the bottom of the ocean the seaweeds form great groves and woods, which lace their branches together and make grottoes and galleries. Many are larger than any trees on land, and as they are many colored, they are probably far more beautiful than our forests. The seaweeds that float often form islands which drift about in the currents. Not far from the Azores is an immense bank of seaweed called the Sargasso Sea from the kind of weed (sargassum) of which it is made up. When Columbus was on his way to the New World, he was greatly astonished at this floating mass, and his men feared that they had come to the end of the navigable sea. Sometimes these plants gather round ships so as almost to stop them.

Many of the seaweeds are very useful to man. In the eastern parts of Europe they are dried for fuel and put on land for manure. The seaweed called bladder-wrack and knobbed rack were once much used for making kelp (see SODA). In northern Europe these are fed to pigs, and when food is scarce even horses and cattle thrive on them. In Holland a kind of seaweed is used in building dykes or banks to keep the sea from flowing on to the land, and the same kind is also used for stuffing mattresses and cushions and for packing goods. The Sandwich Islanders, the Chinese and Japanese, the Icelanders, and many other people eat various kinds of seaweeds. The edible birds' nests of the Chinese are said to be built by swallows out of a kind of seaweed which has much GELATINE in it. Another kind in China contains so much gelatine that it is largely used for making glue and varnish. Among the most useful of the seaweeds is that commonly called Irish moss or carrageen, which takes the place of isinglass in making blanc-mange and jellies, and is used also in making sizing and lager beer. It is a deep rich green when gathered, but is bleached white by wetting it with sea water and drying it. About five thousand barrels are collected every year on the coast of Massachusetts and sent to New York and Philadelphia. Dulse, a purple seaweed, called dillesk by the Irish, is also collected and used for food.

Many beautiful seaweeds are found along our coasts, and when they are gathered and arranged properly they make very handsome collections. Only moist and fresh pieces should be collected. They should be first soaked in a basin of fresh water, to clean them from sand and salt. Then select a good piece, lay it in a soup-plate filled with fresh water, and slip under it a sheet of white paper. While in the water the seaweed may be easily spread out evenly on the paper by means of a camel's-hair pencil or brush. When this has been done the paper may be raised gently from the water, and the seaweed will keep its form. Let the water drain off and then lay the paper on a sheet of blotting paper; over the seaweed lay a piece of linen cloth, and over that another sheet of blotting paper. The linen cloth is put in to keep the blotting paper from sticking to the seaweed. After arranging all the pieces of seaweed in this way, pile them up between two boards and put some weights on them and leave them for three or four days to dry. When dry, take off the blotting paper and rag from each carefully, so as not to pull up the sea-weed.

Most seaweeds are gummy and stick to the paper, but some hard ones need a little mucilage. When well dried the papers may be neatly arranged according to their sizes on the pages of an album. If the specimens are large only one can be put on a page, but if they are small, they may be placed in many pretty ways. A little mucilage under the

corners of each paper will hold them securely.

Seaweeds belong to the lowest class of flowerless PLANTS. They do not have seeds, but grow from spores, as do LICHENS.

The word seaweed is made up of the Anglo-Saxon *sæ*, the sea, and *weód*, weed.

SEED. In the article FRUITS, which should be read before this, it is told that the fruit of a plant is its seed-holder. A seed, or the part from which a new plant grows, is made up of its coat or skin and of its kernel, or part inside the skin. The kernel is made up of the embryo and of the albumen, when there is any. The embryo is the part of the seed which grows, the baby plant. The ALBUMEN is a stock of food laid up for the embryo to live upon

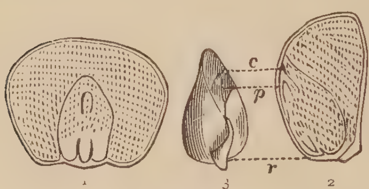


Fig. 1.—Seed of Indian Corn.

before it is old enough to draw food from the earth.

Soak a grain of Indian corn until you can take the skin off. You will then see a thick lumpy body in the middle and reaching down to the small end, which can easily be taken out with the finger nail, if the grain is soaked enough. The part taken out is the embryo, and the other part from which it was taken is the albumen. The parts can be seen in the picture (Fig. 1), where 1 shows a grain of corn cut through flatwise, 2 the same cut through the other way, and 3 the embryo taken out of another grain whole, and placed beside the one cut through so as to match the parts. In this *r* is the radicle (Latin *radix*, root) or part which grows into the root, *p* is the plumule (Latin *pluma*, a feather) or bud which grows up into the stem, and *c* is the seed-leaf, or cotyledon, which forms the first

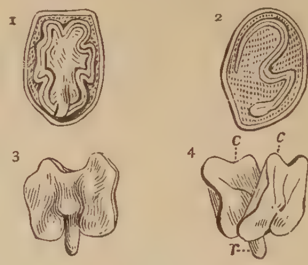


Fig. 2.—Seed of Morning Glory.

leaf of the plant. A seed of the morning glory, cut through and looked at through a magnifying glass, is shown in the next (Fig. 2). In 1 the embryo is seen whole and flatwise in the seed; in 2 it is seen edgewise, lying in the albumen, which is all around it; in 3 it is seen taken out of the albumen and spread out flat; and in 4 its two leaves are separated. The radicle is shown at *r*, and the seed-leaves or cotyledons at *c c*. The plumule cannot be seen. Both the corn and the morning glory seed have albumen to feed the young plant on, but they differ in another way: the corn has but one seed-leaf or cotyledon, and the morning glory has two. This is a very

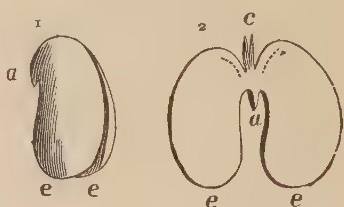


Fig. 3.—Seed of Bean.

important difference, which will be told about hereafter.

The food for the baby plant is not always stored up in this way outside

of the embryo, but it often forms a part of the embryo itself. In such cases the coat or skin of the seed has nothing in it but the embryo. If we take the skin off from a soaked bean, we shall see that it is made up of two thick pieces joined at the upper end by a little stem, as shown in 1 in the Fig. 3. It will be seen better by spreading the parts out flat, as in 2. These two thick parts, marked *e e*, are the seed-leaves or cotyledons, *a* is the radicle, and *c* the plumule. The cotyledons are thick and heavy because they have stored up in them the food for the baby plant. When the bean sprouts, they come up out of the ground and turn green, but after the root and the new leaves have drawn enough food from them they wither and fall off. The seeds of the cherry, chestnut, beech, and almond grow in the same way; but in the pea, acorn, and horse-chestnut, the cotyledons do not come out of the ground.

Embryos are divided into two classes: those with one cotyledon or seed-leaf, and those with two cotyledons or seed-leaves. The first kind are called monocotyledonous, which means with one cotyledon, and the second dicotyledonous, which means with two cotyledons. These are hard words, but they should be learned, as they are found in all botanies, and are necessary to describe plants. The plants which grow from the first kind of embryos are named monocotyledons, and those which grow from the second kind are called dicotyledons.

Seeds do not all stay where they drop, but are scattered in different ways. Some seeds are fitted with thin wings, like maple and pine seeds, so that the wind easily blows them. The seeds of the dandelion have a long thin stem, at the other end of which is a tuft of fine thready down, and those of the thistle are also fitted with down, so that they blow about easily and are carried great distances. Other seeds float away on water, or are carried away by birds or in the wool of sheep and other animals, and dropped in places where they sprout and grow. The burrs which often stick to clothes, and to the manes and tails of horses, are seed-holders whose seeds are thus scattered. Some seeds, too, like those of mosses and ferns, are so small and light that they are blown away by the gentlest breeze.

The word seed is from the Anglo-Saxon *sæd*, seed.

SEPTEMBER. See CALENDAR.

SEQUOIA, the name given by Endlicher to the great trees of California, it is said in honor of the Cherokee chief Sequoyah (see C. P. P., George GUESS). In England it is called Wellingtonia, after the Duke of Wellington; in California it is called the "mammoth tree," and the groves of it the "big trees." The sequoia belongs to the same family with the REDWOOD, but is larger and has somewhat different leaves and cones. It grows on about 200 miles of the western slope of the Sierra Nevadas, from Calaveras through Tulare County, California, and nowhere else in the world. With the exception perhaps of the Australian tree called eucalyptus, the sequoia is the largest of vegetable productions; its trunk being from 25 to 35 feet in diameter and often more than 300 feet high. In the Mariposa grove is one 34 feet in diameter. Through another, 28 feet thick, a passage way has been cut through which the stage coaches pass regularly, yet the tree still lives. In the Calaveras grove is one 325 feet high, supposed to be more than a thousand years old. The wood of the sequoia is red like that of the redwood; when exposed to the light it becomes of a deep mahogany color. The bark, often fifteen inches thick, is cinnamon brown.

SEWING-MACHINE. The first sewing-machine which would sew cloth was made by an Englishman named Thomas Saint in 1790;

though a machine for embroidering had been made some years before (1770). In the first part of this century several other machines were made, in England and in the United States, but none of them came into use. In 1830 a sewing-machine was made in France by a man named Thimonnier, which was used in sewing clothes for the army. Eighty of these machines were broken to pieces at one time by a mob in Paris, because the tailors feared that they were going to do all the work and thus take away their bread, and many others were afterward broken, and the maker died a poor man. About 1833 an American named Walter Hunt, living in New York City, made several sewing-machines which worked well, but he did not take out a patent—that is, he did not get from the government papers giving him the sole right to make them. In 1846 Elias Howe, also an American, having been born in Massachusetts in 1819, made a sewing-machine which in many things was like that made by Hunt, and got a patent on it; and from this have grown all the different kinds of sewing-machines now in use, so that Howe has the name of being the father of the sewing-machine.

The Howe machine uses a needle with an eye near the point, instead of at the larger end, as in the common needle. The thread, carried through the cloth by this needle, forms a loop under the cloth through which a shuttle (see LOOM) is made to pass. The shuttle has in it a BOBBIN of thread which unwinds as it passes through the loop, and the thread thus put through forms what is called the lock stitch. The machine made by Hunt had the same kind of needle, and made the same stitch, but it is generally thought that Howe did not know of it when he made his machine. Almost all the best sewing-machines sew the lock stitch, although all do not make it just alike, some of them not using any shuttle, but passing the thread through the loop in another way. Among the lock-stitch machines are the Singer, the Wheeler & Wilson, the Howe, the Domestic, and the Weed. The Wilcox & Gibbs machine sews what is called the twisted-loop stitch.

The way in which the shuttle lock-stitch sewing-machine works can be seen in the following pictures of the Singer machine, of which more are sold every year than of any other kind. The first figure shows the shuttle, in which *A* is the case or outside part, *B* the bobbin or spool on which the thread is wound, and *C* the thread-guide. When the bobbin is put into the shuttle-case the end of the thread is put under the

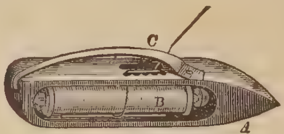


Fig. 1.—Shuttle.

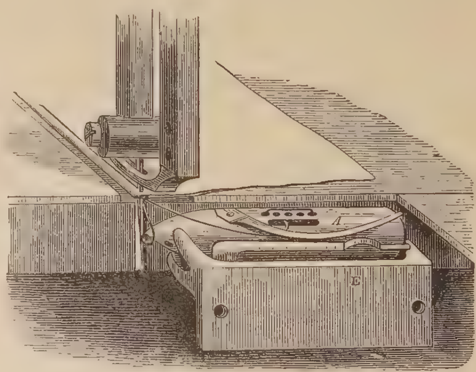


Fig. 2.—Shuttle about to go through the Loop.

little bar below the bobbin, then carried over the top of the bobbin and through the little holes seen on the upper side, and finally under the thread-guide, all of which is well shown in the picture. The thread is put through enough of the little holes to make the right "tension"—that is, to make the thread draw just tight enough to sew well. If it were not for this the thread would pull out too fast and be too loose, so that the stitches would not be tight enough. The thread-guide keeps the thread from knotting and makes it draw straight.

In the second figure, the shuttle *A* is seen in the shuttle-carrier *E*, in which it is carried backward and forward in the machine. The point of the shuttle is shown just going into the loop made by the thread in the needle. Every lock-stich sewing-machine sews with two threads, one in the needle and the other in the shuttle. The needle thread is wound on a bobbin or spool above it, and is put through the eye, which is near the point, as in the Howe machine. When the needle comes down the thread is carried through the cloth close against the side of the needle, but when it begins to move upward. the thread, which is loose, is caught by the cloth and made to bulge out, so as to form a loop, as in the second picture. The machinery is so made that the shuttle-carrier moves forward the very moment the loop is formed, and the shuttle having a sharp point forces its way through, and carries its thread through the loop of the needle thread. The tension and the thread-guide let out just thread enough from the bobbin of the shuttle to form a stitch, and as the needle thread is at the same time drawn up, the stitch is drawn tight in the cloth.

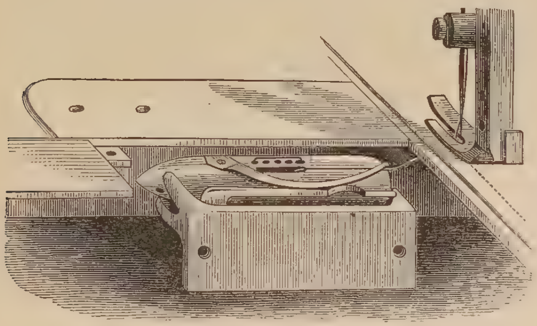


Fig. 3.—Shuttle after passing through the Loop.

After the stitch is tightened the shuttle goes a little further forward, and this unreels enough thread from its bobbin to make the next stitch. This is shown in the Fig. 3, where the shuttle is seen, after having passed through the loop, ready to go back. This it does while the needle is coming down again, so that the instant the loop is made it shall be ready to pass through it as before. In Fig. 4 is shown the lock stitch thus made, but very much enlarged. The stitch is even and exactly alike on both sides of the cloth, the point where the two threads lock together being within the cloth.

Many of the sewing-machines for sewing cloth can be made to do other work than plain sewing, such as hemming, felling, ruffling, cording, embroidering, and making buttonholes; and there are also sewing-machines made for sewing the uppers and the soles of shoes, harnesses, carpets, books, etc.

Fig. 4.—Lock Stitch.

Hundreds of thousands of sewing-machines are made in the United

States every year, many of which are sent to the different countries of Europe, to Mexico, and to Central and South America.

The word sewing is from the Anglo-Saxon *siwian*, to sew. Machine is from the Latin *machina*, a machine.

SHAD, a common fish of the herring family, much esteemed for food. American shad are caught in almost all the rivers of the Atlantic coast as far north as the St. Lawrence. They appear in South Carolina in January, and on the coast of New York and Massachusetts from the end of March to the end of April. They have been introduced also by the United States Fish Commission into the Ohio and other rivers running into the Mississippi, and all the rivers of the Pacific slope from the Sacramento to Puget Sound. They are caught in seine and stake NETS mostly at or near the mouths of rivers, as their flavor is better near the salt water. Shad sold in the New York markets come mostly from the Delaware and Hudson rivers, but some fine ones are brought from the Connecticut river. They are usually eaten fresh, but some are split and salted.

Shad weigh generally two to six pounds. They are bluish on the back, light copper color on the sides and silvery below. Their flesh is very sweet, but is filled with small bones. The eggs or spawn of the shad, commonly called the roe, is also unusually good, and is much sought after for the table. The shad will bite in fresh water at a hook baited with a fly, and give the angler good sport.

The word shad is from the Anglo-Saxon *sceadda*, shad.

SHADDOCK, a fruit of the same family with the ORANGE and LEMON. It grows wild in China and the East Indies, but is now cultivated in the West Indies, whence the shaddocks seen in our markets are brought. The fruit is pale yellow and sometimes as large as a child's head. It is excellent eaten raw for desert, and when cooked makes good preserves.

The shaddock is named from Captain Shaddock, an Englishman, who first brought it from Asia to the West Indies early in the eighteenth century.

SHAGREEN, a kind of leather made from the skins of horses, wild asses, and camels, and grained so as to have on it little pimples or grains. It is mostly made at Astrakhan, in Russia, and in other places in the East. The skins are stretched very tightly and wet with water, and while soft they are sprinkled on the hair side with the hard, round seeds of a plant which grows in the East. The seeds are then pressed into the skin and it is dried.. When dry the skins are beaten to get the seeds out, and they are then shaved down on the other side almost to the dents made by the seeds. When the skins are wet again the dents swell up on the shaved side and make little grains all over it. The skins are then dyed. Shagreen was once much used for covering sword scabbards, and it is still used for covering instrument cases, small boxes, etc.

The word shagreen is from the Persian *saghri*, the leather of a horse's back.

SHALLOT. See ONION.

SHARK, a large sea fish found in almost all the oceans of the world. There are as many as a hundred kinds, some of which are six or seven times as long as a man, while some are not more than a yard long. Sharks have very large mouths, with several rows of sharp three-cornered teeth. They are mostly flesh-eaters, and live on living and dead animals and on other fish. The white shark, or "man-eater," one of the largest and fiercest kinds, and which is found in all the large oceans, will cut a man in two at a single bite, and one has been known to swallow a man whole. All sharks like the flesh of a negro better than that of

a white man. One of the wicked amusements on board of slave ships was to hang the body of a dead negro to the bowsprit and watch the sharks jump for it. It is said they would often catch it when hung more than twenty feet above the water. Sharks are very greedy and will often follow ships for days to eat the waste food thrown overboard.

The sharks commonly found along the Atlantic coasts of the United States are the mackerel shark, which feeds on mackerel, and which is about as long as a man; the gray shark, which is sometimes longer than a man; and the dog-fish. The mackerel shark is often caught for the sake of its liver, which yields six or seven gallons of oil. The skin of the shark is rough; it is sometimes used by joiners instead of fine sand-paper, and the hilts of swords are often covered with it. Large numbers of sharks are caught in the Indian Ocean for the sake of their fins, out of which the Chinese make soup. In Norway and Iceland all kinds of sharks are eaten, the fish being hung up for a year to cure, like hams, to make the flesh tender. The small kinds of sharks are sold in the Paris markets, and the dog-fish is dried and smoked for food in several countries.

White Shark or "Man-Eater."

The word shark comes from the Latin *carcharus*, Greek *karcharias*, a shark, from *karcharos*, sharp-pointed, meaning their teeth.

SHEEP. It is not known where the sheep first came from, but wild sheep are found in many parts of the world. There is one kind in America, called the Rocky Mountain sheep or big-horn, but none of our tame kinds have descended from it. The first tame sheep in the United States were brought from England to Virginia in 1609. These were common sheep, but now most of the best breeds in the world are raised in this country. Some sheep have finer wool than others, but their meat is not so good as that of the coarser-woolled kinds. Among fine-wool sheep are the Merino, French, Saxon, and Silesian: and among coarse-wool ones are the Southdown, Cotswold, and Leicester.

The sheep is one of the most valuable of animals. Its flesh is among the best of foods, its fat makes good tallow, and in some countries the milk is much used both for drinking and for making cheese. From its WOOL is woven woollen and worsted cloths, and from its skin is made leather, PARCHMENT, and vellum.

The sheep is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word sheep is from the Anglo-Saxon *scêp*, *sceáp*, sheep. In German it is *Schaf*.

SHEEPSHEAD, a fish that gets its name from the resemblance of its head to that of a sheep. It is found from Cape Cod to Mexico, but never north of Cape Cod. It is a quiet, bottom-loving fish, found about old wrecks, on which barnacles abound. In the South the sheepshead rarely exceeds two pounds, but about New York harbor it has been caught weighing 12 to 15 pounds, though the average is not more than half that. Sheepshead are caught from June to the middle of September, when they go into the deep sea and are seen no more until the next season. They are among the best of food fishes.

SHELLS. Shells are the coverings of the animals called MOLLUSKS. They are not outside skeletons, like the shells of turtles, but are only the houses in which the animals live. Most mollusks need such a covering, because their bodies are very soft and tender. If you look at an oyster which has just been opened you will see a delicate soft skin lining the shell and covering all the soft parts of the animal. This skin, which is called the mantle, is the part which makes the shell. Shells are made up of lime (CALCIUM carbonate), mixed with more or less of animal matter called ALBUMEN. The mantle takes up lime from sea water and builds it up in thin layers all around the body of the animal. The edge of the mantle does the most of this work, and the shell therefore grows by having new layers of lime and albumen added to its outer edge. New layers are also made all round on the inside, and the shell thus grows thicker and heavier. Mollusks which lead quiet lives, usually lying in one place on the bottom of the sea, have the thickest shell, and those which move around much generally have thin shells. In some shells there is more lime than albumen, making them hard like porcelain, and such shells are usually called porcelain shells. In others there are layers of lime and layers of albumen between them, and these shells are called pearly shells, because they shine like mother-of-pearl.

Shells are usually divided into two classes, univalves, or those which have only one part, such as snail and conch shells; and bivalves, or those made up of two parts joined together with a hinge, like oyster and clam shells. Most of the univalve shells are porcelain shells, and most of the bivalves are pearly shells. Univalve shells are of many different forms, some being shaped like harps, some like spindles, helmets, elephants' tusks, shields, boats, spiral staircases, caps of liberty, and some like spiders. There are not so many singular shapes among bivalves, most of them being plain, like oyster, clam, and mussel shells; but there are a few odd forms, such as the hammer oyster, which when shut up looks like a hammer, and the razor shell, which is long and narrow like the blade of a razor. Shells often change their form in growing, so that those of the same animal at different ages are of different shapes. Some shells are very large: the giant clam, found in the East Indies and in Australia, is sometimes nearly as long as a man and very heavy, the two parts often weighing four or five hundred pounds. A pair of these great shells are kept in the church of St. Sulpice, Paris, where they are used to hold holy water.

Shells have a great many uses. Many are kept in cabinets on account of the beauty of their colors and shape, and rare kinds have often sold for large prices. They have also been used as ornaments, and rude nations often make them into money. The wampum used by the North American Indians for money, and for ornamenting belts and clothes, was made of the shells of

the periwinkle and the quahaug clam. Shells are sometimes made into beautiful vases, baskets, and table tops, and in the East even wreaths and bouquets are formed out of different-colored shells. The uses of mother-of-pearl are told about in the article MOTHER-OF-PEARL. Many univalve shells, especially conch shells, are cut into cameos for jewellery. The conch shells most used are those called bull's mouth and black helmet, in which the layers are of different colors. The upper layer is white or yellowish, and in this the head or other figure of the cameo is cut; and the second layer, which is nearly black, is made into a background. If you look at a shell cameo, you will see how this is. The white part is carved into the form wanted, by means of fine steel tools made of wire and by files, great care being taken not to cut into the black layer in taking the white off, because its natural polish is finer than any which can be given to it, and if it is scratched the whole layer has to be cut off.

The pink conch shell, brought from Panama and the West India Islands, is made into beautiful jewellery which looks somewhat like pink coral, but is not so costly. The part used is the inner lining of the shell, which is the same substance as the pink pearls sometimes found in this kind of shell.

Common shells are used for making roads, are burned into lime for making MORTAR and CEMENT, and for spreading upon land as a manure. Shell sand, found along sea shores, and made by the crumbling up of shells, is also used for putting on land which has too little lime in it.

The word shell is from the Anglo-Saxon *scell*, shell.

SHINER, a little silvery fish found in all streams from New England to Kansas and Alabama. It grows only about ten inches long and is of little consequence as a food fish, though boys like to catch and eat it. It has to be cooked soon after it is taken from the water, as its flesh spoils quickly. For this reason it is called in Alabama rot-gut minnow. It is sometimes called also red-fin and red-dace. The shiner furnishes food for the black bass, the trout, and other fish.

SHINGLE, a thin slab of wood for covering houses. Shingles are made out of various kinds of wood, such as pine, cypress, cedar, chestnut, and oak; but pine and cypress ones are the best. They are made thinner at one end than at the other, so that when nailed in rows on a roof, the thick ends of one row may lap over the thin ends of the one next below it, and thus shed water. Shingles are split, sawed, or shaved off from blocks of wood by machinery. Some are made by hand, being either split out rough, or shaved smooth with a drawing knife. Most shingles are sawn in mills called shingle mills, and put up in bundles for sale.

The word shingle is a corruption of *shindle*, from the Latin *scindula*, shingle, which is probably from *scindere*, to split.

SHIP, the general name of any sea-going vessel larger than an undecked boat. The first to build ships were probably the Chaldeans, who navigated the Persian Gulf. Next came the Phœnicians, famous as sailors, who traded all over the Mediterranean and planted many colonies that became famous also for their ships. They were the first to build biremes and triremes or ships with two and three banks of oars. The Egyptians built vessels of all sizes and had war and merchant fleets. The Greeks were from the beginning interested in navigation and succeeded the Phœnicians as masters of the eastern Mediterranean. The Carthaginians, a colony of the Phœnicians, were the first to build quadriremes and quinqueremes, or ships with four and five banks of

oars. The Romans learned to build ships from them.

Ancient Ships. The war ship or long ship, seven or eight times as long as broad, was a galley propelled by oars rowed by slaves chained to their seats. These vessels were named according to the number of banks or rows of oars each had: unireme (1 bank), bireme (2), trireme (3), quadrireme (4), quinquereme (5), sexireme (6), septereme (7), etc., up to 10, 15, and even 20 banks. These vessels had generally one mast, though sometimes two, with one large square sail, and a strong sharp prow to ram an enemy with. They were steered by two paddles over the stern, one on each side, as in Figs. 1 and 2.

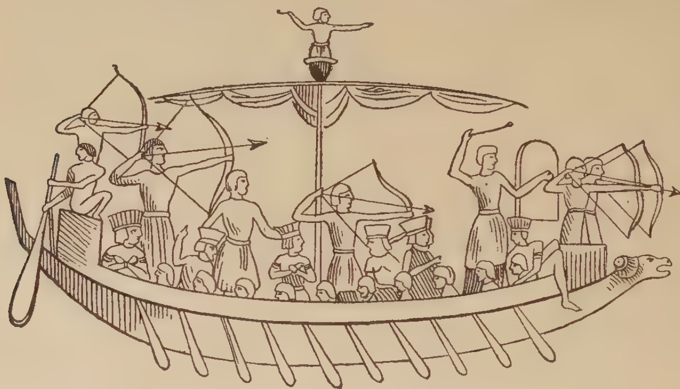


Fig. 1.—Egyptian War Ship: From a Bas-Relief at Thebes.

Merchant ship swere shorter and often quite large, some having three masts and accommodations for 500 passengers. They were good sailors, too, and often made quick voyages.

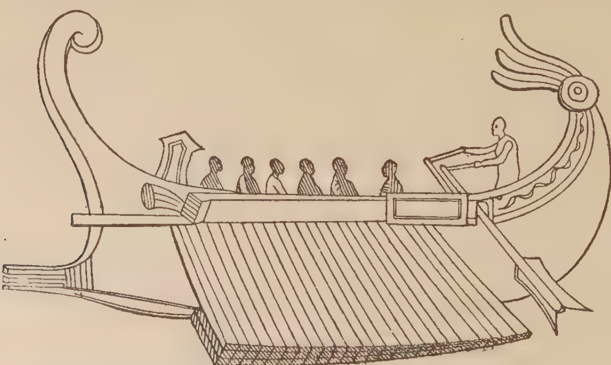


Fig. 2.—Roman Trireme: From a Picture in the Museum at Naples.

Modern Ships. The ships in which William the Norman invaded England were small one-masted vessels like that shown in Fig. 3, taken from a picture in the Bayeux Tapestry (see BAYEUX, C. P. P.). After the Crusades commerce revived in

the Mediterranean, and ships rapidly increased in number, size, and kind. The introduction of the mariner's compass, of maps, and of instruments for navigation soon followed, making longer voyages possible, and led to the discovery of the New World. Both row-galleys and sailing vessels were used at this time. Row-galleys were variously called galiot, dromon, galea, galea bastarda, galea grossa, galeasse, etc.; and sailing vessels, balæna, carabella or caravelle, galleon, huissier, carrack, flibot, barca or bark, brigantina, frégate, frégatone, etc., from which can be seen the origin of some of our modern names. Some of these vessels had two or three decks, and one, two, three, and four masts were used, with one, two, and three sails on each. As on ancient ships, the paddle was at first used to steer by, but the rudder took its place in the fourteenth century.

The ships in which Columbus made his voyages were the kind called caravelles, small lateen-rigged vessels of 50 to 180 tons burthen. The lateen-rig consists of a triangular sail fastened on a long spar or yard which is hoisted up on the mast. Lateen sails are used on native vessels on the north coast of Africa and are seldom seen out of the Mediterranean. There are no pictures of Columbus' ships left, but they were probably much like those shown in

Fig. 3.—Norman Ship: From the Bayeux Tapestry.

Fig. 4, which is a fac-simile of designs of ships of the fifteenth century from the maps of Juan de la Cosa, the pilot of Columbus.

The discovery of the New World, which led to longer voyages across the Atlantic, made larger ships a necessity. Great merchant ships were built, at first by Spain and Portugal, then by England, France, and Holland, which traded to all parts of the world; and this brought about the construction of larger and more powerful war ships and the formation of navies. In the sixteenth and seventeenth centuries very large men-of-war, high in the stern and bow, were built, armed with many cannon (Fig. 5). The Royal Prince of the British navy, built in 1610, carried 55 guns, and the Sovereign of the Seas, built in 1637, 86 guns on three dcks. The ships of the eighteenth century were still larger, some of them carrying 110 and 120 guns.

Iron and Steel Ships. Up to the nineteenth century all ships were built of wood, but in 1818 the first iron ship, the Vulcan, was built on the river Clyde, Scotland. Many improvements in form and rigging followed, until the "clipper," a long, sharp, fast-sailing ship, was designed, the best sailing vessel ever made. Clipper ships were first built at Baltimore, whence they are sometimes called

Baltimore clippers. They became famous for quick voyages around Cape Horn to California in 1849-50, and were noted also for many years in the Canton trade. The early clippers were built of wood, but iron ones were constructed later. One of the largest of the wooden clipper ships, the Great Republic, of 3000 tons, had four masts.

In 1860 steel began to be used in building ships, and it has gradually gained until now most of the great war ships are constructed wholly of it, as steel is lighter and stronger than iron. With the use of iron and steel the size of sailing vessels increased. It was thought at one time that the STEAMSHIP would altogether take the place of the sailing ship, but

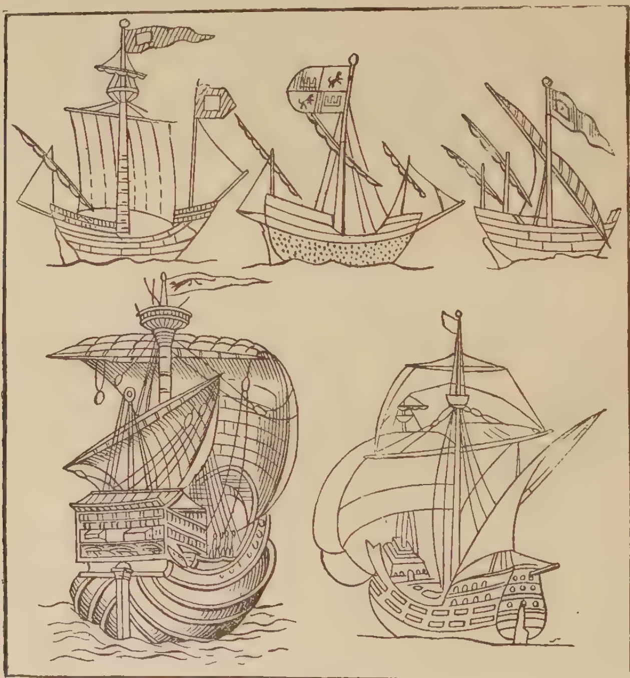


Fig. 4.—Ships of the Fifteenth Century.

it has been found that large sailing vessels can make long voyages at a profit. Several steel ships lately built have four masts, and a French ship, La France, built in Scotland, has five masts which, as well as the yards, are of steel. Four of the masts are square rigged and one fore-and-aft rigged. This ship will carry more than 6000 tons. Her size can be better understood by a comparison with some of the great ships of former times. The Henry Grace à Dieu, a very large war ship of the sixteenth century, was only 1000 tons; the Royal Sovereign, of the seventeenth century, then the largest ever built, 1861 tons; and the Royal George, the greatest English ship of the eighteenth century, only 2280 tons. But larger ships were difficult to build before it was found out that

iron and steel could be used, for wood is not strong enough.

Classes of Ships. Modern war ships are classed by the number of their guns, by their tonnage, by their rig, by their shape, etc. In the sixteenth, seventeenth, and eighteenth centuries men-of-war were classed according to their guns. Ships carried from 4 to 120 guns; so, an 18-gun ship meant a ship that carried 18 guns, a 74-gun ship, 74 guns, etc. Ships were sometimes classed also by the number of their decks on which guns were carried: as ships-of-the-line, which carried guns on two or three decks; and frigates, sloops, etc., which had only one gun-deck. Afterward vessels were classified by rates, according to their tonnage: first rates were vessels of 4000 tons and upward; second rates, 2000 to 4000 tons; third rates, 900 to 2000 tons; and fourth rates, under 900 tons. In the United States navy, first rates are vessels over 5000 tons; second rates, 3000 to 5000 tons; third rates, 1000 to 3000 tons; fourth rates, below 1000 tons. Merchant vessels are classed by insurance companies according to their sea-worthiness, into three classes, first, second, and third. The first class is divided into three grades, A 1, A 1—, and A $1\frac{1}{2}$; the second class into A $1\frac{1}{2}$ and A 2; and the third class into A 2— and A $2\frac{1}{2}$.

In common usage ships are classified according to their rig: as ship, bark, barkentine, brig, brigantine, schooner, sloop, cutter, etc. All these, excepting schooners, sloops, and cutters, are called square-rigged vessels, because most of the sails are square; they are, too, bent on spars or yards fastened across the masts. Schooners, sloops, and cutters are called fore-and-aft rigged vessels, because the spars on which the sails are bent run fore and aft, that is, lengthwise of the vessel, instead of across the mast.

A **Ship** proper is a vessel with three masts, all rigged with square sails, or sails on yards. A ship is made up of the hull, or body, which sits in the water; the spars, which include the masts, yards, bowsprit, and other timbers above the hull; the rigging, or ropes, chains, etc., of which there are two kinds, the standing-rigging, which supports the masts, and the running rigging, by which the sails are set and furled; and the sails.

The hull consists of the bow or forward part, the waist or middle part, and the stern, or after part.

Fig. 5.—Ship of the Sixteenth Century.

The upper deck, which is open to the sky, is called the spar-deck. Its raised sides are named bulwarks (from French *boulevard*, rampart). The part of the spar-deck forward of the first mast is called the forecastle (the fore castle; in former times ships had a castle at each end, in which the fighting men were placed); the part between that and the next mast the waist; and the part back of that the quarter-deck. The right-hand side of a ship, looking toward the bow, is called the starboard side: and the left-hand the larboard or port side. Next below the spar-deck is the main-deck, and

below that, in large men-of-war, is the gun-deck.

The front mast of a ship is called the foremast, the next or middle one the mainmast, and the hindmost one the mizzenmast. Each mast is made up of three pieces, because no trees grow tall and strong enough to make it of one piece. The different pieces, which are bound together with strong iron bands, are called by different names: the second piece of each being called the topmast, and the third piece being divided into two parts, the lower one called the topgallant mast and the upper one the royal mast. Thus, the foremast is made up of the lower part, the fore-topmast, the fore-gallant mast, and the fore-royal mast; the mainmast

Fig. 6.—Full Rigged Ship.

1, Fore-course; 1*a*, Fore studding sails; 2, Fore-topsail; 2*a*, Fore-topsail studding sails; 3, Main-topsail; 3*a*, Main-topsail studding sails; 4, Mizzen-topsail; 5, Fore-topgallant sail; 5*a*, Fore-topgallant studding sail; 6, Main-topgallant sail; 6*a*, Main-topgallant studding sail; 7, Mizzen-topgallant sail; 8, Fore-royal; 8*a*, Fore-royal studding sail; 9, Main-royal; 9*a*, Main-royal studding sail; 10, Mizzen-royal; 11, Fore-skysail; 12, Main-skysail; 13, Mizzen-skysail; 14, Fore-topmast staysail; 15, Jib; 16, Flying Jib; 17, Spanker; 18, Spenser; 19, Main-royal staysail; 20, Main-topgallant staysail; 21, Mizzen-royal staysail.

of the lower part, the main-topmast, the main-topgallant mast, and the main-royal mast; and the mizzenmast of the lower part, the mizzen-topmast, the mizzen-topgallant mast, and the mizzen-royal mast. Sometimes still another mast is added above the royal mast, called the sky-sail mast. At the head of each of the lower masts is a kind of platform called the top; and at the head of each of the topmasts are cross-bars of timber called the cross-trees. On each one of the parts or divisions of a mast is a yard, a long slender piece of timber on which the sail is stretched. These yards and sails are named after the part of the mast on which they are fastened; thus, on the mainmast are the main-

yard and the mainsail; on the main-topmast, the main-topsail yard and the main-topsail; on the main-topgallant mast, the main-topgallant yard and the main-topgallant sail; and on the main-royal mast, the main-royal yard and the main-royal sail. These sails are all square sails. The sails on the other masts are like those on the mainmast, and are named after their masts in the same way, with one exception; the mizzen-mast has no square sail on the mizzen yard (commonly called cross-jack yard), but has instead of it a sail like the mainsail of a sloop or schooner, which is called the spanker. The flag or ensign of the ship is usually hung from the top of this sail. A like sail, called the spenser, is also sometimes carried on the mainmast. Besides these sails a ship has sails called staysails between the masts, others called studding sails, carried on the ends of the square sails, and several in front called jibs. The jibs, of which there are usually three, are fastened to ropes stretched from the foremast to the bowsprit. The bowsprit is a long piece of timber running out from the bow, and is made up of three parts, of which the inner part is called the bowsprit, the middle part the jib-boom, and the outer part the flying jib-boom. The sails on these, which are three-cornered, are named the flying jib, the jib, and the fore-topmast stay-sail.

In Fig. 6 is shown a square rigged ship with all her sails, the names of which can be seen by the letters and the description underneath.

When the mizzenmast of a square rigged three-masted vessel has no yards, but is fore-and-aft rigged, the vessel is called a bark; and when both the mainmast and the mizzenmast are fore-and-aft rigged, it is called a barkentine.

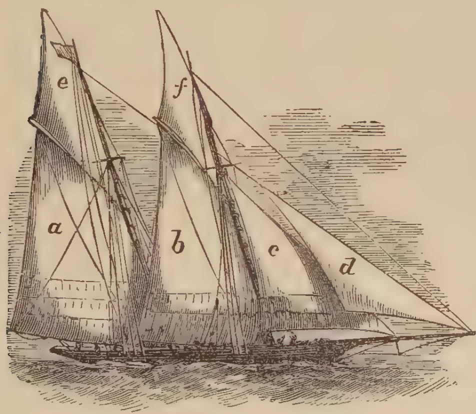


Fig. 7.—Schooner.
a, Mainsail; *b*, Foresail; *c*, Jib; *d*, Flying jib; *e*, Main-gaff topsail; *f*, Fore-gaff topsail.

A brig is a vessel with two masts, both of which are square rigged. Sometimes a brig has the mainmast rigged fore-and-aft, and it is then called a hermaphrodite brig.

A brigantine is like a hermaphrodite brig, but has a square topsail and topgallant sail on the mainmast. A schooner is also a vessel with two masts, but both are rigged fore-and-aft, as shown in Fig. 7. The masts, which are named foremast and mainmast, are each in two parts, a lower mast and a topmast. The principal sails are the mainsail *a*, on the main-mast, the foresail *b*, on the fore-mast, and the jib *c*, forward of the foremast. The mainsail and the foresail are not stretched between yards, as in square rigged vessels, but between a gaff and a boom. The gaff is the wooden piece on the top of each of those sails, and the boom the similar, but longer, piece at the bottom. Mainsails always have a gaff and a boom, but

foresails sometimes have no boom, and are then called lug-foresails. Schooners carry also above the mainsail and the foresail, smaller three-cornered sails, called gaff top-

Fig. 8.—Topsail Schooner.
a, Mainsail; *b*, Foresail; *c*, Jib; *d*, Flying jib; *e*, Square topsail; *f*, Square topgallant sail; *g*, Gaff topsail.

sails, because they are fastened to the gaffs, and a second jib, *d*, called the flying jib. Sometimes a schooner has a square topsail, and sometimes a topgallant sail, stretched between yards, at the top of the foremast, and is then called a topsail schooner.

A three-masted schooner is a long schooner with three masts. But schooners are now often built with four masts, and several five-masted schooners, one of which can carry more than 3000 tons, have been built. Schooners lie nearer to the wind than square rigged vessels and require fewer men, and therefore are much used as coasters. The schooner is wholly an American vessel, the first one ever made having been built by Captain Andrew Robinson, of Gloucester, Massachusetts, about 1713.

A **Sloop,** is smaller than a schooner and has but one mast. Its sails are a jib, a mainsail, and a gaff topsail; and some have a square topsail. A sloop-of-war, a kind of naval vessel now seldom seen, is rigged either as a ship, a brig, or a schooner, and carries 18 to 32 guns.

A **Cutter** is a one-masted vessel rigged like a sloop, with a bowsprit that runs in and out, not fixed as in the sloop. It gets its name from its fast sailing. See YACHT.

Fig. 9.—Whaleback.

A **Lugger** is a vessel of two or three masts with lug sails. A lug sail is a four-sided sail bent upon a yard that is hoisted upon the mast by halliards. The lugger is a common type of vessel on the English and French coasts, but is seldom seen here, though the rig is sometimes used on small craft.

A **Whaleback** is a new form of vessel first built at Superior, Wisconsin, in 1888, by its inventor, Alexander McDougall. The first one launched was ridiculed and

named "the pig" by steamboat men, and vessels of her kind are still called "steam pigs." Whalebacks, which are built of steel, are somewhat like a whale, being round both on the top and bottom, with ends coming to a point like a cigar. As they have no deck the water washes over them instead of against them. They are built both as steam propellers and as barges. On the latter the wheelhouse is in a turret built up above the round deck; the steamers have also a cabin built in the same way. They have been very successful on the lakes and some think they will bring about a great change in shipbuilding. In 1891 one named the Charles H. Wetmore went from Montreal to Liverpool, being the first one to cross the Atlantic.

The word ship is from the Anglo-Saxon *scip*, ship.

SHIP-WORM. This ANIMAL, which is rightly called the teredo, was once thought to be a worm, but it is not a worm, though its body looks long and worm-like. It is covered with a sort of sheath or shelly coat,

Ship-Worm.

and is a kind of MOLLUSK. It is called ship-worm because it bores holes into ship timbers, and often injures them so much that they will crumble at the touch. Not only ships' timbers but all other kinds of woodwork under water are eaten by it. Once the coast of Holland was threatened with a deluge, because the ship-worm ate the PILES of the dykes which kept out the sea, and it cost a great deal of money to repair them.

The ship-worm is grayish white, and is generally six or eight inches long. Its shape can be understood from the picture. The larger end, wrongly called its head, because this kind of mollusk has no head, is the one with which it bores. The other end is divided into what may be called two tails. When the larva or young ship-worm is first hatched, it swims around looking for some wood in which it may bury itself. When it finds a piece to suit it, it begins to cut a hole. It is not known exactly how it works, but it has strong MUSCLES in front, and as the wood is softened with water, it is supposed that the moving of these muscles takes out the wood little by little. It feeds on the wood as it goes, and when it is about halfway in it covers the sides of the hole with a kind of slimy matter which hardens into a shell. Each teredo makes a hole for itself and never cuts into another hole, though the spaces between are often so thin that the wood is cut up like a honey-comb, and a little pressure on the outside will crush it. Ships' bottoms are covered usually with copper plates to save their timbers and planks from these animals.

The word ship-worm is made up of the Anglo-Saxon *scip*, ship, and *wyrm*, worm.

SHOE, a covering for the foot, usually made of leather. If it covers only the sole or a small part of the foot, it is called a sandal or slipper; and if it covers a part of the leg it is called a boot. The most ancient form of shoe was the sandal, which was nothing but a sole fastened with straps. The Egyptian priests wore sandals of palm leaves and papyrus, and the common people wore leather. The Romans wore sandals in the house just as we wear slippers, but for outdoor wear they had shoes. The shoe soles of Roman soldiers were studded with nails. The soft buckskin shoes of the American In-

dians are called in their language moccasins. In Japan common people wear shoes made of plaited straw, and in South America of plaited hemp and grass.

Shoes are largely made in the United States, chiefly in Massachusetts, New Hampshire, and Maine, but most of the finer kinds are made in New York, Philadelphia, and other large cities. Fine shoes are made mostly by hand, but the commoner kinds are largely made by machinery. Some machines sew the uppers and some the soles, and others peg soles. The pegging machine makes its own pegs as it works, and can easily peg on the soles of two pairs of women's shoes in a minute. The pegs are made out of white birch wood, which is fed to the machine in strips. The sole sewing machine can sew on the soles of eighty shoes in an hour. Another machine will sew together the soles and uppers of 450 pairs in a day. All machines for sewing shoes are of American invention. The wooden peg was invented in 1818 by Joseph Walker of Massachusetts. All shoes, whether made by hand or by machinery, are shaped over a wooden form called a last, of the shape of the foot. Almost all shoes for women and children are made by machines, but the finest kinds of men's shoes are sewed by hand.

In France, the Netherlands, and some other European countries working people wear wooden shoes, and they are worn also in the United States, particularly in the West, by workers in tanneries, dyeing establishments, and other damp places. There are several wooden shoe factories in Grand Rapids, Michigan, where thousands of pairs are made every year, chiefly from basswood. Some are engraved and painted and made quite elegant in form. Clogs or pattens are shoes with leather uppers, and soles and heels of maple or ash. Those made for clog-dancers have finely trimmed soles and decorated uppers.

The word shoe is from the Anglo-Saxon *sceó*, *sceóh*, shoe.

SHOT and SHELL. Shot means rightly anything fired from a gun or cannon with gunpowder, but hollow shot made to burst after being fired are generally called shells. The balls used in rifles are commonly called bullets, and are told about under that name, so in this article only small shot used by sportsmen in shot guns or guns for hunting, and large shot and shell used in cannon will be described.

Small Shot are not cast in moulds like bullets, but are made by dropping melted lead from the top of high towers called shot-towers. The lead of which they are made has a little arsenic mixed with it, which makes it softer and causes it to take the round form more easily. When mixed, it is poured into moulds and made into bars, and these are hoisted up to the top of the shot-tower. Some shot-towers are as high as a church steeple; they have to be much higher for making large shot than for making small shot. At the top of the tower is a furnace in which the lead is again melted, and it is then poured on to iron plates full of little round holes, so placed that the lead after going through the holes will fall down to the bottom of the tower. The shot are made round and hard by falling through the air, and are cooled by dropping into a cistern of water at the bottom. They are then dried, separated into different sizes by sifting them through sieves, and polished by turning them round in a kind of barrel with some powdered BLACK LEAD. Sometimes the lead is poured down deep pits in the earth, instead of from the top of towers. At Newcastle, in England, a deserted coal-pit is thus used.

Cannon Shot. When cannon were first made, round stones were used for shot, but after a while balls were

made out of metal, generally lead or iron; now shot and shell are made of iron or steel. Cannon shot are of two kinds, those to be used in smooth-bore guns—that is, guns whose barrels are smooth inside, and those to be used in rifled guns, or guns whose insides are cut in grooves, as told under RIFLE. Shot for smooth-bore guns are generally round, and those for rifled guns long and pointed. Long shot cannot be fired very well in smooth-bore guns, because they need grooves to make them go straight, but round shot can be fired in rifled guns. Three kinds of shot are used in smooth-bore cannon: 1, Shot; 2, Shell; and 3, Case-Shot.

1. Shot are round balls of solid iron, cast in sand. At first only one ball was cast at a time, and the shot were rougher and less perfect than

Fig. 1—Round Shot as Cast.

they are now made; but afterward shot were cast four or five at a time, joined together as shown in Fig. 1, and afterward turned smooth in a LATHE.

2. Shell, or bombs, are like round shot, but are cast with a core of sand, which when taken out leaves a hollow space with a hole opening outside. This space is filled with powder and has a fuse or slow match in the hole. The shell is put into the gun with the fuse toward the muzzle or mouth, and when the gun is fired the flame of the gunpowder lights the fuse in front. The fuse is made just long enough to burn down to the powder by the time the shell reaches the place it is aimed at, and the shell then bursts. Such a fuse is therefore called a time fuse. Another kind is the percussion fuse, which explodes when the shell strikes.

3. Case shot are made up of small shot in a case or envelope of some kind. There are three kinds in common use; grape-shot, canister-shot, and shrapnel.

A grape-shot is made of several small cast-iron balls, so fastened together that they may be loaded in

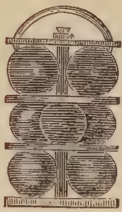


Fig. 2. Grape Shot.

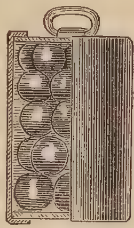


Fig. 3. Canister Shot.

a gun all at once. In the United States nine balls are used, put together between iron plates in three layers, as shown in Fig. 2. The firing of the gun bursts the plates apart, and the balls scatter as soon as they leave the gun.

A canister-shot, Fig. 3, is made up of a sheet-iron or tin can filled with small iron or lead balls, the spaces between them being usually packed with sawdust. The canister bursts as soon as it leaves the gun and the balls are thus scattered and do great execution among large masses of men. In the picture a canister-shot is shown with one side of the can partly cut away, so that the balls can be seen.

A shrapnel shot is made up of a cast-iron shell filled with musket balls, into which melted sulphur or resin is poured so as to fill up all the spaces between. This hardens and makes the ball into a solid mass. A hole is then bored down through the sulphur and bullets, of a size just large enough to hold gunpowder enough to burst the shell. Shrapnel, which are named after Colonel Shrapnel of the British army, who made the first ones about 1808, are used in both smooth-bore and rifled can-

non. Those for smooth-bore guns are made round, and are commonly called spherical (round) case shot (Fig. 4). They are fired, like shell, by a fuse, made just long enough to burn down to the powder in a given

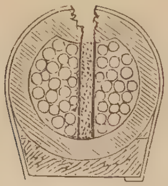


Fig. 4.—Spherical Case Shot.

time. In battle fields shrapnel shot are fired at large bodies of men and are timed to burst a short distance before reaching them; the bullets and the pieces of shells, which keep on in the same way, are thus spread out and made to kill many more than a single shot would.

The shot used in rifled guns are commonly made of steel, and long and pointed, much like a sugar loaf in shape. They have to be very carefully made and are far more costly than shot for smooth bore guns. There are four kinds: 1, Solid Shot; 2, Shell; 3, Shrapnel; and 4, Case Shot.

1. Shot are cast solid and then turned smooth and even in a lathe.

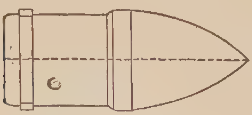


Fig. 5.—Solid Shot.

They are made in different ways to suit the different kinds of rifling in guns. Fig. 5 is a kind used in French rifled guns.

2. Shell (Fig. 6) are cast, like round shell, with a sand core which comes out leaving the shell hollow. This is loaded with gunpowder or some other explosive, and fired either with a time or a percussion fuse.

Battering or armor-piercing shell are much like common shell, but are

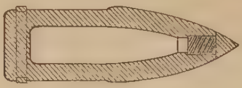


Fig. 6.—Shell.

thicker and have only a small hollow in them. Large ones may be stronger than solid shot, because the hollow in them makes them cool more evenly when cast. They are used for battering walls and for firing at armor-clad ships. They are quite expensive, each one costing from $150 to $275.

3. Shrapnel (Fig. 7) are made much like spherical case shot, differing only in shape. The small balls

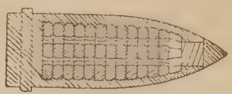


Fig. 7.—Shrapnel.

are put into a hollow in the middle, and the shell is burst by means of a fuse, lighted when the gun is fired or by percussion.

4. Case shot (Fig. 8) are hollow cases filled with bullets, which scatter when the case explodes. Those made for rifled guns are the same in principle as spherical case shot.

In former times many other kinds of shot and shell were used, most of which are now old-fashioned. Among these were the chain-shot, made up of two balls joined by a

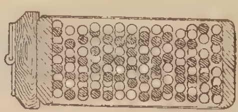


Fig. 8.—Case Shot.

chain, used to cut the masts and rigging of a vessel, and bar-shot, joined by an iron bar instead of a chain. Carcasses are shells filled

with some substance which will burn furiously, and which have holes in them through which the fire can blaze out and set buildings on fire. They are sometimes thrown into cities and towns to burn them. Hand grenades are small shells or bombs filled with gunpowder and having a time or percussion fuse. They are thrown by hand, and are used especially in defending forts to throw among masses of men who are attacking. They are also used in sea fights to throw on to the decks of vessels; and assassins have sometimes tried to kill sovereigns with them. In 1858 an Italian named Orsini, with several others, tried to kill Louis Napoleon and the Empress Eugenie by throwing three grenades under their carriage. Many people were killed and wounded, but the

Shoulder-Straps of the United States Army.

Emperor and Empress were unharmed. The dynamite bombs used by Anarchists and Nihilists are a kind of hand grenade, made generally to explode when thrown. The Emperor Alexander II. of Russia was killed by one in 1881.

The word shot is from the Anglo-Saxon *sceótan*, to shoot. Shell is from the Anglo-Saxon *scel*, shell.

SHOULDER-STRAP, a strap worn on the shoulder by officers of the army and navy to mark their rank. Shoulder-straps are worn only by commissioned officers, that is, officers who have their commission or title from the head of the government of a country. Under officers, such as sergeants and corporals in the army, and gunners and boatswains in the navy, who are commonly called warrant officers because they get their power from papers called warrants, which are given them by

commissioned officers, usually have their rank told by marks on the collars and sleeves of their coats.

The **Commissioned Officers** of the army are as follows: general, lieutenant-general, major-general, brigadier-general, colonel, lieutenant-colonel, major, captain, first-lieutenant, and second-lieutenant. Of these the general, lieutenant-general, major-general, and brigadier-general, are called general officers, because they command bodies of men larger than regiments; and all the others regimental officers, because they command only regiments and parts of regiments.

The commissioned officers of the navy are as follows; admiral, vice-admiral, rear-admiral, commodore, captain, commander, lieutenant-commander, lieutenant, junior lieutenant, and ensign.

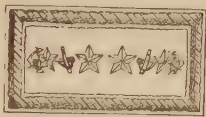
Uniform of Army. All officers of the army wear a double-breasted frock coat of dark blue cloth, and all general officers wear trousers of dark blue cloth without any stripe on the sides. Regimental officers wear light blue cloth trousers, with a stripe on the sides one and a half inches wide; the stripes being colored according to the part of the army the officer belongs to: in the infantry, white; artillery, red; cavalry, yellow. For common wear a sack coat of dark blue cloth may be worn by officers. Common soldiers wear a dark blue single-breasted frock coat, and sky blue trousers without stripes; but sergeants wear a stripe one inch wide and corporals a stripe one-half inch wide, white in the infantry, red in the artillery, and yellow in the cavalry. General officers wear black ostrich feathers in their hats, and regimental officers cock feathers; those of the infantry are white, and of the artillery red. Regimental cavalry officers wear yellow horse-hair plumes, and light horse-artillery red horse-hair plumes.

Shoulder-Straps of Army. The cloth of shoulder-straps in the army differs in different parts; for general officers it is dark blue with a gold embroidered border; for regimental officers of infantry, white with gold border; of artillery, red with gold border; and of cavalry yellow with gold border. The marks of rank, as shown in the pictures, are put on the cloth inside the gold border, and are as follows: general of the army, two silver stars with the arms of the United States between them; lieutenant-general three silver stars the middle one larger than the others; major-general two silver stars; brigadier-general one silver star; colonel, a silver spread eagle; lieutenant-colonel two silver leaves; major, two gold leaves; captain, two silver bars at each end; first lieutenant, one silver bar at each end; second-lieutenant, plain strap without marks. The highest rank in our army is now (1893) that of major-general.

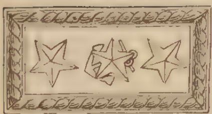
Uniform of Navy. All officers of the navy wear, when on duty, a double-breasted frock coat of navy blue cloth, with two rows of large navy buttons on the breast; trousers of navy blue or white linen duck cloth, according to the season of the year and a navy blue cloth cap with a gold cord and a silver shield with two crossed anchors in front. Different sleeve ornaments of gold lace are worn by different officers. On visits of ceremony, such as visits to the President, to the Secretary of the Navy, and to foreign officials and vessels of war, officers of the navy wear blue dress coats with epaulets and cocked hats; but no officer below the rank of lieutenant wears cocked hat or epaulets. When off duty on board ship, blue sack coats may be worn, but never on shore nor in a foreign port.

Shoulder-Straps of Navy. In the navy shoulder-straps are worn only by officers above the rank of midshipman. Midshipmen, or cadets just graduated at the Naval Academy, wear the mark of their rank,

a silver anchor, on shoulder loops instead of on straps. Shoulder-loops are ornaments of gold embroidered cord, made somewhat like the top part of an epaulet without the fringe, and with a centre of blue cloth. All shoulder-straps in the navy are made of navy-blue cloth, with a gold embroidered edge. The marks of rank, put on the cloth inside the border, as shown in the pictures, are as follows; admiral, four silver stars, with a gold anchor under each of the stars at the end; vice-admiral, three silver stars, with a gold anchor under the middle one; rear-admiral, two silver stars, with a silver anchor between them; commodore, one silver star between two silver anchors; captain, a silver spread eagle between two silver anchors; commander, two silver oak



Admiral.

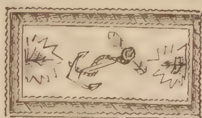


Vice-Admiral.

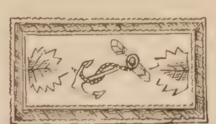
Rear-Admiral.

Commodore.

Captain.



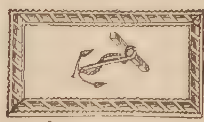
Commander.
(Silver Leaves.)



Lieutenant-Commander.
(Gold Leaves.)

Lieutenant.

Junior Lieutenant.



Ensign.

Shoulder-Straps of the United States Navy.

leaves with a silver anchor between them; lieutenant-commander, two gold oak leaves with a silver anchor between them; lieutenant, two gold bars at each end, with a silver anchor in the middle; junior lieutenant, one gold bar at each end, with a silver anchor in the middle; ensign, a silver anchor. The highest rank in our navy is now (1893) that of rear-admiral.

SHRIMP. The common shrimp is one to two inches long, and is usually gray, spotted with brown. It feeds on worms, slugs, and other small animals, and is itself eaten by fishes and birds. In England and France shrimps are much used for food, but in this country they are caught mostly for bait, although they are often seen in our markets cooked for sale.

The shrimp is a CRUSTACEAN of the order *decapoda*, or ten-footed animals, which include also lobsters, crabs, and crawfish.

The word shrimp is Middle English, and means the same as *scrimp*, anything small.

SICKLE. See SCYTHE.

SILICON, one of the principal non-metallic ELEMENTS. With the exception of OXYGEN, it is the most abundant of all the elements. It is never found free, that is by itself, but always united either with oxygen alone, forming silica (silicon oxide), commonly called rock crystal or quartz, which is often found in beautiful crystals, as clear as glass or ice; or with oxygen and some of the metals, forming silicates of those metals. About one-fourth part of the rocks which form the earth's surface are made up of silica, and it is found also in many plants, especially in the outer skin of the stalks of the GRASSES. The bark of the rattan is made hard and flinty by the silica in it. Sandstone, sand, flint, agate, opal, amethyst, carnelian, etc., are made up mostly of silica. The silicates, made up of silica and some of the metals, are very important in the arts. Clay is an aluminum silicate, and MICA is a silicate of aluminum, iron, and potassium. Silicates are also made by art. For example, the different kinds of GLASS are silicates of sodium or of potassium, or of both mixed with silicates of other metals, such as calcium, lead, and aluminum.

The word silicon is from the Latin *silex*, flint.

SILK, the fibre or thread spun by the SILKWORM. The cocoons, from which silk is obtained, are taken from the twigs to which they are fastened before the moth begins to eat its way out, and thrown into hot water. This kills the moth inside and softens the gum with which the threads of silk are stuck together. The outer floss covering is then opened at one end and the cocoon with the fine silk around it is slipped out. The silk is not spun round and round the cocoon like thread wound round a spool, but is passed backward and forward, first in one place, and then in another, so as to cover the whole cocoon.

When the cocoons are to be unwound they are put into a trough of hot water which is divided into four parts. Four or five cocoons are dropped into each one of these, and the threads of each are joined and drawn together through an eyelet, which scrapes off a good deal of the gum and makes one thread of the four or five threads. The four threads thus made from the cocoons in the four parts of the trough are afterward brought together so as to make one thread, and wound upon a reel. When all the silk is wound off from one cocoon, another is put in its place, and so on until all are unwound. The silk thus obtained, which is of a bright yellow, is called raw silk.

About three hundred yards of thread are generally got from each cocoon, but some have less than others. The reeled or raw silk is made up in China and Japan into bundles called books, which are sent to foreign countries to be spun into thread and woven into cloth. But before it is fit for use it has to be carefully washed, and then made ready for the weaver by "throwing." The word throwing comes from the Anglo-Saxon *thrawan*, to twirl or twist, and the silk is said to be thrown when it is doubled and twisted into the right kind of thread for spinning and weaving. It is done in different ways for making threads for different kinds of silk cloth, such as plain silk, flowered silk, velvet, and ribbons, and on machines made much like those used in cotton spinning. The threads are then boiled in soap and water to get out the gum, and afterward dyed.

Most of the raw silk used is

brought from Asia, chiefly from China, India, and Japan, but a good deal is made in Italy, France, and Russia. Silk thread and cloth are made chiefly in France, Italy, the United States, Germany, Great Britain, Switzerland, and Belgium, Very fine sewing silk is now made in this country, and very good dress goods, ribbons, braids, and trimmings also are made here.

The word silk is from the Anglo-Saxon *seolc*, which is from the Latin *sericum*, Seric cloth, so called from Serica, the ancient name of China, perhaps from the Chinese word *se*, which means silk.

SILKWORM. The silkworm, from which we get silk, is the caterpillar of a kind of MOTH that feeds on the leaves of the mulberry tree. This moth came first from the north part of China. It has a thick, hairy body, about an inch long, stout legs, and large white wings, marked with dark bands. The female is larger than the male, and a little different in form in the body, as may be seen in the pictures. She dies soon after laying her eggs, and the male does not live much longer.

The eggs, which are about as large as mustard seed, are laid singly on the leaves of the mulberry tree, where they are fastened by a

Silkworm Moth, Female.

sticky gum. Each female lays three hundred to seven hundred eggs. The eggs may be preserved a long time, if kept cool and free from damp; but if put in a warm place they will hatch out in a few days. When they first come from the eggs, the larvæ or young caterpillars are very small, but they soon begin to eat greedily of the mulberry leaves and then grow very fast. The silkworm lives as a caterpillar six or eight weeks, during

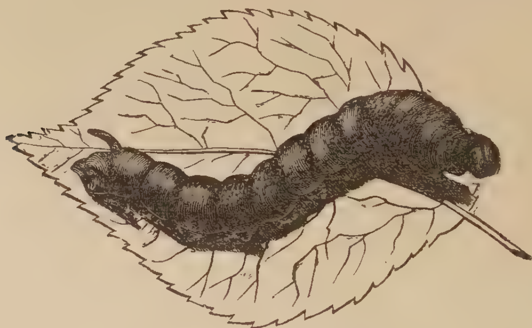
Silkworm Moth, Male.

which it changes its skin four times, growing in size and in greediness each time, and when full grown is about three inches long and of an ashy or cream color. Its body is made up of twelve joints, the last one of which has on it a kind of horn, and it has sixteen legs. The full-grown caterpillar is shown in the third picture.

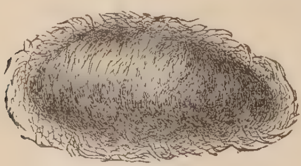
At the end of about five weeks the caterpillar stops eating, and crawls about, moving its head around and looking for a good place to spin its cocoon (see INSECTS), which is made of silk from its own body. Near the head are two little bags, filled with a kind of gum. These bags end in two tubes or pipes, which join together in the under lip and form a single tube, through which the gum is drawn and spun into silk. Each thread of silk as it comes from the worm is thus made of two strands or threads. After spinning a few coarse threads to hang itself by, the caterpillar folds itself up much like a horseshoe, with its legs outward, and then spins silk all over its body, moving its head round and round. The outside of the cocoon is covered with what is called floss silk, but within all is made of fine silk, stuck together with gum.

The size and shape of the cocoon are shown in the picture. The thread of which it is made is all in one piece, and about a thousand feet long. About the fourth day, when it has spun out all its silk, the worm inside becomes of a waxy-white color. In time the skin wrinkles and comes off, being pushed off down toward the hinder parts, and the larva enters on its second stage of life and becomes a pupa or chrysalis (see INSECT), being at first white but afterward dark red. The form of the pupa is shown in the last picture.

The silkworm lives in its second state fifteen to seventeen days, during which a thin skin is formed over it in which the pupa changes to a winged insect. At the right time it breaks this skin, and then wets one end of the cocoon with a liquid from its head, which soaks through the whole thickness of the silk threads and separates but does not break them. The moth works its way through the passage thus made, and comes out into the light of day. It is then wet, but soon dries itself and becomes a perfect moth. The cocoons from which the insect has come out do not give as good silk as those which have not been opened, so in silk-making countries it is usual to kill the chrysalis by steaming the cocoons.

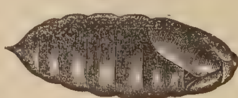


Silkworm Caterpillar, Full-grown.



Silkworm Cocoon.

There are other kinds of silkworms from the cocoons of which silk can be got, some of which feed on oak leaves, some on the leaves of the castor-oil plant, and some on those of the ailantus tree; but none of them are so useful as the Chinese silkworm.



Silkworm Pupa.

The silkworm has been raised in China from the most ancient times, and for a long period all the silk used in the world was brought from there. Laws were made forbidding the people from sending any silkworm eggs out of China, or from telling anything about the manufacture of silk. But at a very early time silk was also made in India, and a

good deal of it was sent from there by caravans. The Emperor Justinian I., who reigned at Constantinople from A. D. 527 to 565, tried to bring the art of raising silkworms into Europe. At last, it is said, two monks went to China, and succeeded in bringing some of the eggs, concealed in their walking-sticks, out of the country. They took them to Constantinople, where they were hatched and the larvæ fed on mulberry leaves, and from them all parts of the Eastern Empire were in time supplied with worms. In Southern Greece great numbers of silkworms were raised, and it was probably from this that the name of the Peloponnesus was changed to Morea, from *morus*, the Latin name of the mulberry tree.

For a long time Europe got all its silk from Greece and Constantinople, but in the eight century the Arabs carried the silkworm into Spain. After the twelfth century it became known in many other parts of Europe, and Italy soon became the principal place where silk was made. In the sixteenth century it became an important business in France. The chief countries where raw silk is now made are China, which makes the most, and after it, Italy, India, France, Japan, Russia, Turkey, and Persia. Efforts have been made to raise silkworms in this country, but they have not been very successful.

The silkworm belongs to the order *lepidoptera*, or scale-winged INSECTS, and to the same family with the butterfly.

The word silkworm is from the Anglo-Saxon *seolc*, silk, and *wyrm*, worm.

SILVER, a METAL, and one of the principal ELEMENTS. It is one of the most valued of the metals. It is found in many places, but never entirely pure, being usually mixed with mercury, gold, or copper, and sometimes with other metals. When pure, silver is white, very bright, takes a beautiful polish, is harder than gold and softer than copper, and is easily hammered out into thin sheets and drawn out into wire. It does not unite with OXYGEN easily, and therefore never tarnishes in the air, whether wet or dry, but when brought near to SULPHUR turns black, forming sulphide of silver. Eggs turn silver black because they have sulphur in them.

Most of the silver of commerce is got from ores of silver, chiefly sulphides (silver and sulphur) and chlorides (silver and CHLORINE). The ores are roasted in fires, then crushed to powder by machinery, and mixed with MERCURY, which unites with the silver and forms a kind of pasty mass called an AMALGAM. This is then heated in close iron vessels, and the mercury passes off as a vapor, leaving the silver by itself. The mercury vapor goes into another vessel called a receiver, where it is cooled by water and turns back to liquid mercury again. Much silver is also got from galena (LEAD sulphide), which usually has silver in it. The lead is melted in large iron pots and let cool slowly, being stirred all the while. The lead forms in hard crystals which settle to the bottom of the liquid metal, whence they may be dipped out in colanders or strainers, which let the silver run through them. By remelting the metal and doing the same thing several times, most of the lead can be got out, leaving the silver.

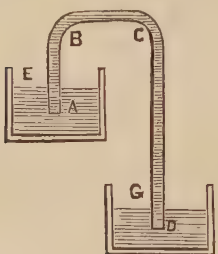
Silver, next to gold, is the most valued of the metals for use in the arts. As the pure metal is too soft to wear well, it is usually hardened by mixing a little copper with it. The silver coins of the United States and of France are made of one part copper and nine parts silver; those of Great Britain have a little less copper, and those of Germany a little more copper. The compounds of silver are very valuable. Among them are the nitrate of silver (silver nitrate), made up of silver and NITRIC

ACID, much used in taking PHOTOGRAPHS, making indelible INK and hair dyes, and in medicine as lunar caustic; and silver chloride, made up of silver and chlorine, which is also of great importance in photography.

The chief silver-producing countries of the world are the United States and Mexico. The most important silver mines are in Nevada and Colorado. Much is also got in Central and South America, Germany, Austria, Spain, Italy, and other countries.

The word silver is from the Anglo-Saxon *siolfor*, silver.

SIPHON, a bent tube used for drawing off a liquid from one vessel to another. In the picture the tube



Siphon.

A B C D is a siphon. The shorter leg, A B, is put into the liquid E, which is to be drawn off into G. If the air be taken out of the tube the pressure of the AIR on the surface of the liquid in E will force the liquid up the tube A B, and it will then fill the whole tube and continue to run until all the liquid in E has run into the vessel G.

The word siphon is from the Latin *sipho*, a tube, a pipe.

SKATE. The first skates were made of bone, and they were tied to the feet with strings. Iron or steel skates are supposed to have been first made by the Dutch, who have used them for a long time for travelling on the many canals with which their country is crossed. Men go to their labor on skates, and market women skate to town early in the morning with heavy baskets on their heads. In Sweden and Norway, where there are many lakes, men, women, and children may be seen skating on every pleasant winter day; and in England and Scotland, too, there are many fine skaters.

Skates were formerly made with grooved bottoms, so that the two sharp edges would cut into the ice and thus keep the skater from slipping sideways, but they are now generally made flat on the bottom. The irons are usually curved a little on the bottom, and rounded up at both heel and toe. There are many different kinds of fastenings for skates: some have straps and buckles, some are made to fit the foot like a shoe, and some are fastened to the sole of the boot with metal clamps. The irons of the best skates are sometimes plated with nickel to keep them from rusting. Common skating, that is, skating straight ahead, is easy to learn, but fine skating is very hard and needs much practise. The best skaters can go backward as easily as forward, and can cut all kinds of graceful curves and figures on the ice.

Roller Skates are made for use on wooden floors or smooth pavements. In place of runners, like common skates, they have four wheels of wood, or composition. Racing skates are now made with ball-bearings and wheels $2\frac{1}{8}$ inches in diameter. Some good skaters can skate as well with such skates on a floor as they can with common ones on ice, and exhibitions are sometimes given by them in theatres and large halls.

The word skate is from the Dutch *schaats*, skate.

SKIN. The skin is the covering of the body, and it hides and keeps from injury the muscles, bones, nerves, arteries, and veins. The skin of most animals is covered with hair and fur, feathers, scales, bony

plates, or shells, but that of man is nearly bare, and he has, therefore, to wear clothes to suit the weather. The skin is nicely fitted to all parts of the body, being loose and wrinkled in some places where it would not do to have it tight, and thick in those parts which are much used, such as the palms of the hands and the soles of the feet.

To the naked eye our skin appears quite smooth, but when looked at through a MICROSCOPE, it is seen to be covered with little scales. The skin is made up of two different layers. The upper layer, called the epidermis, is a mass of little bodies or cells packed closely together. On the top these are pressed so flat that they form scales, but lower down they are round or oval. On parts of the body where it is thick the epidermis may be cut or shaved off without harm, for there are no bloodvessels in it. This part of the skin is always growing, and the top scales are all the time being rubbed off. Whenever the hands are washed some of it is rubbed off and it would soon be all worn away if new cells were not always growing at the lower part and moving up to the top and drying into scales. Thus the epidermis is always being renewed. The nails of the fingers and toes of men, the claws of birds and of flesh-eating animals, the hoofs and horns of cud-chewing animals, the shell of turtles and tortoises, whalebone, and the quills of birds are all made up of the same things as the epidermis, and are really a part of it. They have cells like those of the epidermis, and like it are all the time growing and wearing away. The nails of man grow so fast that they have to be cut often to keep them neat. They should always be cut at the ends and never at the sides, and should be kept clean with a nail brush and never scraped with a knife. Biting of the nails is a bad habit which not only spoils their beauty, but often makes sore fingers which are hard to cure.

Under the epidermis is a lower layer, called the dermis or true skin, which grows fast to it but may be separated from it as may be seen when the upper skin is raised by a blister. The dermis is not smooth on top, but is raised up in little hills, called papillæ, over which the epidermis fits so as to fill up all the hollows between. The papillæ are filled with bloodvessels, and of course when cut into will bleed. On account of these bloodvessels the true skin is always red, and it is this which, shining through the whitish epidermis, makes it pink or flesh-colored. Wherever the epidermis is thinnest, there the skin is reddest, as in the lips, the inside of the mouth, etc. The skin on the inside of the mouth is not generally called skin, but mucous membrane, but it is made up in much the same way as the skin on the outer parts of the body. The epidermis is generally dry, but the dermis is always damp, because some of the waste parts of the blood pass through the skin of the bloodvessels and thus wet every thing round them.

Though the epidermis is generally dry, it is sometimes quite damp, as when we sweat or perspire. This is because the outer skin is full of little tubes, which run down through both layers of skin and twist up in a knot at the end among the capillaries or bloodvessels. The waste parts of the blood are always oozing through the skins of the capillaries into these tubes, which are rightly called glands, and much of it turns into vapor and passes off into the air; but often, when the capillaries get very full of blood, these tubes or glands fill up with a watery fluid and overflow at their mouths, or pores as they are commonly called, over the outside skin. We call this fluid sweat or perspiration. When we take violent exercise the blood rushes to the outer parts of the body, and

a great deal of this fluid is thrown off. As this is waste matter from the blood, our health requires that the pores should always be kept open. As told above, the scales of the skin are all the time coming off, so that we are always shedding our outer skin. If this be left on the body, it will mix with the perspiration and in time form a kind of paste which will harden and fill up the pores, and the skin will then become inflamed and diseased. Stopping up the pores of the skin has even led to death. Many years ago the body of a little boy, who was to take part in some public procession in Italy, was covered with gold leaf. To make the gold leaf stick, his skin was covered with a kind of varnish; this filled up all the pores, so that the perspiration was wholly stopped, and the little fellow died a few hours afterward.

The best way to keep the skin healthy is to wash it often with warm water and soap. The whole body should be washed once every day, and such parts as the hands and face, which are open to the dirt, several times a day. In this way the dry scales of the skin will be got rid of as soon as they become loosened, and the pores will be kept open. Generally, the water used should be of the same heat as the air of the room, but in winter it may be a little warmer (see BATH).

The word skin is from the Anglo-Saxon *scinn*, skin.

SKUNK. The skunk is found only in America. It is generally about eighteen inches long, with very short legs, and a long tail. Its fur is usually black, with a white tuft on the end of the tail. It lives in burrows in the ground, and feeds on birds, eggs, small mammals, reptiles, insects, and fruits. The skunk is a timid animal and slow in its motions, but has a strong defence against its enemies in a very offensive fluid, carried in little bags under its tail, which it has the power of squirting ten or fifteen feet, in two fine streams. The odor is so strong that it is almost impossible to get it out of clothes touched by it. Notwithstanding this the skunk is a very clean animal, and is careful not to get the fluid on its own fur. The flesh of the skunk is white and juicy; it is much liked by the Indians, and is eaten by many white people also. The skins are valuable for the fur, and the grease of the animal is good for dressing leather. The skunk can easily be raised in captivity, and increases very fast. Near Lima, New York, is a skunk farm, where about a thousand a year are raised for their skins, which sell for $1.50 each.

The skunk is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family.

The word skunk is shortened from the Indian *seganku*, skunk.

SLATE, a hard, tough rock, which easily splits up into thin plates. It is usually fine-grained, and of a grayish or bluish black or greenish blue color, but sometimes green and reddish brown. The largest slate quarries in the world are in Wales, more than 3000 men being employed in them. There are also fine quarries in Scotland and France, and in the United States in Pennsylvania, Vermont, Maine, New York, Maryland, Virginia, and other States. Slate is usually quarried either by blasting it out in large slabs, or by splitting it off with wedges. The slabs are split up into sheets by driving wide thin chisels between the layers with wooden mallets, and the sheets are then cut up into the sizes wanted. In this country much of the cutting and trimming of slate is done by machines. Large slabs for mantels, table-tops, and other ornamental furniture are sawn out with circular saws, and then planed smooth by planing machines like those for planing metals. The surfaces of such slates are sometimes enamelled to look like marble or other fine stones, and then baked in

ovens, and polished. Large slate slabs are used also for making the beds of billiard tables, counters for stores, and sinks. Small sheets of slate are used for roofing buildings and for writing slates. Roofing slates are split out rough and squared, and have two small holes made in one end for the nails by which they are fastened to the roof boards. Writing or school slates and slate blackboards are split and cut into the right shapes, and then polished smooth with PUMICE-stone. Slate pencils are made of a kind of soft slate stone, of which the best is found in Vermont. The stone is sawn into small blocks and split into sheets about a quarter-inch thick, then planed smooth in one machine and cut into pencils in another. The dust and small pieces are afterward ground into flour and also made into pencils, so that none of the slate is wasted.

The word slate is from the Old English *sclate*, French *esclat*, a splinter.

SLEIGH, SLEDGE, SLED. What we call a sleigh in the United States is called a sledge in England. In this country we go a sleigh riding, but in England they go a sledge driving. The name sled is commonly given to a kind of sledge used for drawing heavy loads on snow or ice, and also to small hand sleighs used by children for coasting or sliding down hill. Light sleighs made to be drawn by one horse are usually called cutters.

In Russia, in the northern parts of the United States, and in other countries where there is much snow in winter, sleighs are made very handsome, almost as much care being taken in their construction as in that of CARRIAGES. The principal kind of sleigh in Russia is called a troika, which is somewhat like our large sleighs, with seats for four persons inside, facing each other, and a seat in front for the driver. But the troika is drawn by three horses, the one in the middle being harnessed in the shafts, and having a wooden arch over his back with sleigh-bells on it; the other two have each a trace on the outside, and a strap in front by which they are fastened to the collar of the middle horse. They are driven with four reins, two for the shaft horse, and one each for the outsiders. The shaft horse trots, but the outer ones usually gallop. In St. Petersburg coaches and coupés also are made into sleighs by taking off the wheels and setting the bodies on runners, just as is done sometimes in this country.

In Russia sleighs are generally all of the same form, the nobleman's differing from the peasant's only in the greater richness of its wood and metal work, and of its cushions and furs; but in Holland they are made of a great many different shapes. Sleighs or sledges made in the form of swans, dragons, and sea-shells, with their panels beautifully painted and gilded, and drawn by horses decked with plumes and bells, or pushed from behind by skaters, may be seen in winter gilding over the frozen canals. In Lapland and the northern parts of Sweden and Norway, where snow lies on the ground a great part of the year, sleighs called pulkas, which are made somewhat like boats, are used, drawn by reindeer. Wrapped in furs, and packed closely in his pulka, the Laplander is drawn with great swiftness over the frozen snow by a single reindeer, which he drives with one rein.

In the Arctic regions dogs are much used for drawing sledges. The Esquimaux have a breed of dogs which they train for this purpose, often harnessing six or eight of them to one sledge. They draw their masters at great speed over the snow and ice, often carrying large loads besides. These dogs are also much used for travelling by Arctic explorers when their ships are frozen up in the ice.

In Canada the Indians make a kind of sled which they call a "toboggan," and with which they often travel hundreds of miles over the snow to the trading posts, dragging on them loads of furs for sale. A toboggan is made out of a thin board of some hard wood, such as bass, oak, or ash, curved up in front like the dash-board of a sleigh, and strengthened with a kind of frame tied together with leather strings. Toboggans are much used also in Canada for coasting, and a great many are made every year for gentlemen and ladies in Montreal, Quebec, and Ottawa, where they are very fashionable (G. and S., 728).

The word sleigh is probably a form of sledge or sled, which is from the Anglo-Saxon *slidan*, to slide.

SLOOP. See SHIP.

SLOTH, a South American animal, so called from its slow and clumsy movements. Sloths are found in the wooded parts of tropical America, and as far northward as Mexico. They live on trees, generally suspended beneath the branches, even sleeping in that way, and stay on one until they have stripped it of its leaves, when they move on to the next one. They are about two feet long and their coarse woolly hair resembles in color the bark of the trees they live on. The female has one young at a time, which clings to her back, hiding among the hair, until old enough to climb.

SMELT, a small fish of the salmon family, found in Europe and North America. The common American smelt, caught along the Atlantic coast from New York northward, is five to ten inches long, coppery green on the back and silvery-white beneath. It goes up rivers in spring and returns to the sea in autumn. Great numbers are caught at these times both in nets and by hook, and sent to market, where they meet with a ready sale, as they are very sweet and delicate.

The word smelt is Anglo-Saxon and Danish; Norwegian *smelta*, a name given to any small fish.

SMILAX, the common name of a delicate vine belonging to the asparagus family. It was brought originally from the Cape of Good Hope, and is now raised largely by florists in greenhouses. It has small tuberous roots and slender branching stems which climb often 20 feet or more. Its leaves are bright green, and the flowers, which are small and whitish, are followed by green berries about the size of those of asparagus. Smilax is one of the most popular of decorative plants, as it does not fade soon, and its stems and leaves are so delicate that they can be used almost anywhere. It makes a very pretty window plant in rooms where the atmosphere is not too dry.

The word smilax is Greek, and means the yew tree.

SNAIL. There are many hundred kinds of snails, some of which are found in all parts of the world. The common garden snail, the form of which is well shown in the picture, has a soft jelly-like body, and a hard shell. The lower part of its body, which is called the foot, is long and flat. By drawing this up and pushing it out again the animal can creep, but not very fast. When at rest the whole body can be drawn into the shell.

Garden Snail.

The snail has a head with two pairs of feelers on it, shown on the right side of the picture. The upper pair,

which are larger and longer than the lower pair, can be entirely drawn into a kind of sheath. The round knobs on the ends of these are the eyes of the snail. At the end of the head is the mouth, with a horny toothed jaw on the upper lip, against which the animal presses its food with its tongue. It can thus chew tender leaves, fruit, mushrooms, and other soft things. Snails feed mostly in the night time, and will often spoil a garden in a single night. They live usually in damp places, such as the shady walks of parks and gardens. On the coming of cold weather they crawl under a stone or log, draw the body into its shell and spend the winter in a numb state.

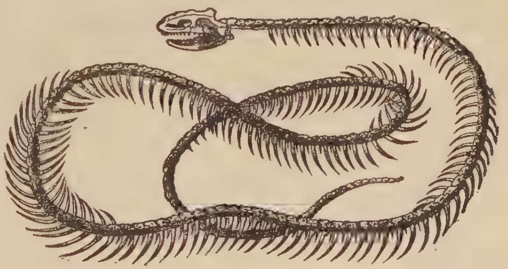
The ancients used to eat snails and thought them to be great delicacies. The Romans served up several kinds brought from different countries, at their feasts, and so great was the demand for them that parks were made where snails were raised and fattened, just as is now done with oysters. After the fall of the Roman Empire snails were not eaten much for several hundred years, but they are now eaten in Austria, Italy, and France, both cooked whole and made into soup, especially during Lent.

The snail is a MOLLUSK of the family *gasteropoda*, or belly-footed animals.

The word snail is from the Anglo-Saxon *snægel*, which is from *snican*, to creep.

SNAKES. These reptiles, which are also called serpents, have long narrow bodies, without any neck, and without limbs. Like other vertebrate ANIMALS, they have a backbone, a skull, and ribs, but no other bones. The backbone is made up often of several hundred joints, almost all of which have two ribs joined to them, one on each side, as shown in the picture. The backbone is so jointed that their bodies are very limber and can be turned in any way or even twisted up into coils and knots. They have an under skin covered with scales, and over this a thin skin which is shed every year and sometimes oftener. When the time comes for it to be cast off, it begins to part at the head and then peels off toward the tail, being turned inside out just as the finger of a glove is sometimes turned in pulling it off. Snakes living in cold climates usually lie in winter in clefts of rocks or in holes under trees in a numb state, and shed their skins when they wake up in the spring. Several hundred of different kinds have been dug out of a single hole, where they had got together to keep warm.

Snakes can creep, spring, climb, swim, squeeze things tight in their folds, hang themselves by the tail, and burrow in the ground, and some can stand up nearly straight. They creep by means of their ribs, each one of which ends in a scale on the outside of the skin. When these scales are pushed backward against



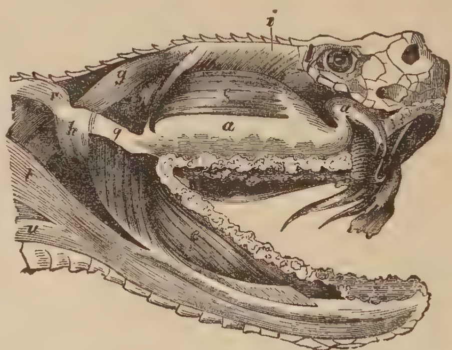
Skeleton of Snake.

the earth, the snake's body is moved along just as if they were so many little feet to walk upon. A snake's track on the ground is crooked, and the windings are always sideways and not up and down, as is sometimes seen in pictures. When a snake springs, it coils its body up

like a coil of rope and then by suddenly straightening it out throws itself forward. It can thus leap more than its own length. Snakes can climb trees and can go up very steep places which are rough enough for their scales to catch hold of, but they cannot creep at all on smooth surfaces like glass. Some snakes live in damp marshy places, some in sandy deserts, some among rocks, some in thick woods, and some in fresh and some in salt water. Some spend most of their time in trees, and some burrow in the ground. Most snakes can see well, though their eyes are small and covered with a horny scale, but their senses of hearing, smell, touch, and taste are dull. Their teeth are sharp, but they use them only for piercing and holding on to their prey and never for cutting up or chewing their food. They feed on living prey, which they swallow whole. They eat and drink but seldom, and can go a long time without eating, waiting for their food to digest. Some snakes catch their prey by running, some spring upon it from among bushes or from the limbs of trees, some poison their victims, and some charm birds and small animals so that they come within reach of their jaws. Snakes feel mostly with the tongue, which is long, tough, and forked at the end, but they do not bite or sting with it as many think.

Most snakes are hatched from laid eggs, but in a few kinds the young are born alive. The eggs, which have soft, thin shells, are usually in a kind of chain, stuck together with a gummy substance. The mother does not make any nest, but hides the eggs away in some safe place, and leaves them to be hatched by the sun and by rotting vegetable matter which gives off much heat by fermenting (see BEER); but some kinds of snakes coil around their eggs and hatch them. Young snakes are of the same shape when born as they are when they grow up, and most of them are able to take care of themselves as soon as they leave the shell; but there are a few kinds which look after their young ones and when danger is coming open their mouths and let them run down their throats, letting them run out again as soon as a safe place is reached.

There are about a thousand kinds of snakes in the world, most of which live in hot countries. They are divided into two classes, those whose bite is poisonous and those which are not poisonous. Among the poisonous snakes are the rattlesnake and copperhead of the United States, the cobra de capello (Portuguese, snake of the hood) of southern Asia and the viper of middle and southern Europe. The rattlesnake is so called because it has some loose bony rings at the end of its tail which rattle when the tail is shaken. It is not known exactly what the rattles are for: some think they are to frighten other animals, and some that they are to call other rattlesnakes. Like most other poisonous snakes it has a flat three-cornered head, and in its mouth are



Head of Rattlesnake, cut open to show Poison Bag.

two sharp fangs or pointed teeth with which it bites. These fangs, which are shown in the picture raised up and ready to bite, usually lie down flat when the mouth is shut. These are the only large teeth the snake has. Each has a hollow running through it, as shown in the third picture, and each has a little canal running from its base to the poison bag, marked *a* in the second picture. The parts marked *e*, *i*, *g*, *h*, and *u* are muscles by which the jaws are opened and shut. When the rattlesnake bites, the muscles which close the jaws press at the same time on the poison bag and squeeze some of the poison through the canal into the fangs, from which it goes into the wound. The poison, which is a tasteless, colorless liquid, goes into the blood of the animal bitten and usually kills it. Small animals die in a few minutes, and horses, cattle, and men generally in a few hours, although some have lived several days and some have recovered from a rattlesnake bite. There are several kinds of rattlesnakes in the United States, most of which live in the hot parts. The hog can kill rattlesnakes well, as it hunts them fearless of the fangs, which are harmless to it. Settlers in a new country where rattlesnakes abound often turn a drove of hogs loose to clear the way for their home.

Fang of Rattlesnake.

The copperhead is the most poisonous American snake, next to the rattlesnake. It is named from its color, which is reddish-brown or coppery. In some places it is called also "chunkhead," from the shape of its head, and "deaf adder," because it sometimes seems to be deaf. It lives in damp, dark places, and feeds on frogs, mice, birds, and lizards. From its thick body and short tail it is very slow and clumsy, but it is more to be feared than the rattlesnake, because it lies hidden in the grass, and has no rattle to tell people where it is. Almost all the other kinds of snakes in America are harmless; though they sometimes bite, their teeth are solid and they have no poison bags.

The poison fangs and the poison of all the deadly snakes are much the same. Few people are killed in this country by snake bites, but in Asia and Africa, where poisonous snakes are numerous, many die from this cause every year. In India alone more than ten thousand persons have been killed in one year. Almost all these were bitten by the cobra de capello, yet the people of India worship this dreadful serpent. If one is found in a house it is petted, fed, and tenderly cared for. Indian jugglers or snake charmers carry cobras around with them, wind them about their necks, and make them do various tricks. They can make them come out of their holes at any time by playing on the flute.

The most remarkable of all the snakes which are not poisonous are those called boas, which include the pythons of the East Indies, the boas and anacondas of the warm parts of America, and others. All the boas are called constrictors (from Latin *constringere*, to draw together by binding), because they kill their prey by winding themselves round it and squeezing it. They have no poison fangs, but have long, sharp teeth with which they seize and hold on to an animal while winding their folds around it. They draw the folds tighter and tighter until all the bones are crushed, then wet the body with their spittle, which is thick and oily, and swallow it whole. Their jaws

and throat are so made that they will stretch easily, and a boa can thus swallow an animal much larger that its own body. After such a meal it lies in a numb state until its food is digested, which often takes several weeks.

The python of the East Indies is sometimes five times as long as a man, and is able to crush and swallow whole a buffalo or a tiger. These snakes pile up their eggs and coil around them, laying their head on the top, and thus hatch them by the warmth of the body. The rock snake of South Africa is usually a little shorter than the python, but it is as large round as the body of a stout man. There are several kinds of boas in America, the largest being the anaconda, which is sometimes forty feet long. It lives mostly in watery places, especially where rivers and narrow streams are shaded by thick woods, and often lies in wait for animals that come to drink. It can swim, can stay a long time under water, and may often be seen floating lazily on the surface of a stream. It also climbs trees and lies coiled among branches. The Indians in South America kill anacondas with guns and bows and arrows, eat their flesh, and make shoes and bags of their skin, and oil of their fat.

Snakes or serpents form an order of the class of REPTILES.

The word snake is from the Anglo-Saxon *snaca*, which is from *snican*, to creep. Serpent is from the Latin *serpens*, serpent, which is from *serpere*, to creep.

SNAPPER, the name of a family of favorite food fishes of the Gulf of Mexico and eastern Florida. The red snapper, of a uniform rose red, averages eight to nine pounds, and sometimes reaches even thirty and forty pounds. It is caught in large numbers off the coast of Florida and sent to the Northern markets.

The **Gray Snapper**, of a greenish-olive with brown spots on each scale, sometimes reaches 60 to 80 pounds in the Bermudas.

SNIPE, the common name of a family of wading birds, with short legs, and a long, straight, slender bill. The snipe is found in both Europe and America. The gray snipe of North America lives in flocks near the sea, where it feeds on worms, insects, and small shell-fish; but the common or Wilson's snipe is seldom seen on the sea-shore, and lives mostly on leeches and other worms. It is about ten inches long, and is brownish-black above spotted with yellowish-white, and whitish below. Its eggs are olive yellow, specked with brown. This snipe goes to Canada to breed in the summer, and returns south in the autumn. Its flesh is delicate and highly prized for food.

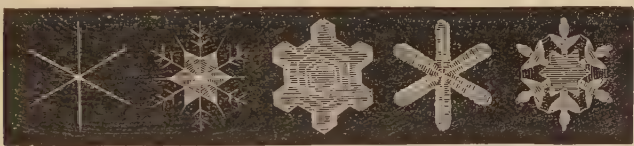
The snipe belongs to the order *grallatores*, or wading BIRDS.

The word snipe is in Danish *sneppe*, German *schnepfe*, snipe, meaning a snipper.

SNOW. In the article RAIN it is told that the watery vapor in the air is changed, according to circumstances, into DEW, rain, HAIL, or snow. When it is condensed, or changed into water at a heat below the freezing point, it forms crystals and becomes snow. Thus snow is nothing but water frozen or made solid up in the air before it falls. When looked at with the naked eye snow flakes appear to be all alike, but they are not. When viewed through a MICROSCOPE snow is seen to be made up of many beautiful little crystals as regularly formed as those of quartz. These are of a great many different shapes, but they usually have the form of a six-pointed star, like those shown in the picture. Some snow crystals are as much as an inch wide, but they are usually much smaller. The colder the weather is, the smaller they are. Much more snow falls in the night than in the daytime. Snow flakes bring with them in falling all the fine

dust in the air, so that the atmosphere is always very pure after a snow storm. Sometimes snow is tinged red, green, yellow, or black, by very small plants which become mixed with it in the air. In the polar regions snow falls every month and lies on the ground all the year round, and even in the hottest countries it is always to be found on the tops of high mountains, but it usually melts before it reaches the lower lands, and comes down as rain. The flooding of rivers from the thawing of snow on mountains carries much rich soil to the plains and makes fertile lands out of barren wastes. The snow which lies on the ground in winter keeps it warm and saves plants from being injured in very cold seasons.

Sometimes such great quantities of snow fall that immense damage is done. One of the worst snow storms known in America was in 1717 (February 19 to 24), when the snow lay five to six feet deep all over New England. Terrible snow storms sometimes occur in the Highlands of Scotland. One which lasted for thirteen days in the year 1620 is still told about by the Scotch shepherds, who call it the "thirteen drifty days." The cold was greater than was ever before remembered, and when the storm ceased, on the fourteenth day, not a living sheep was to be seen on many of the higher farms. Whole flocks were huddled together in their folds frozen stiff, and though some on the lower farms lived through the storm, the greater part of them died afterward from the exposure. On the 24th of January



Forms of Snow Crystals.

1795, occurred another great snow storm in which seventeen shepherds and thousands of sheep and other animals lost their lives. Whole flocks were buried up in the snow, and no one knew where they were until the snow melted, when they were all found dead. Many, too, were swept off into the rivers and never heard of.

In the famous mountain pass of the Great Saint Bernard, in the Pennine Alps, the snow lies in winter from ten to forty feet deep, and travellers are often lost in it. Many hundreds have been rescued from death by the efforts of the monks, who live in the monastery near the highest part of the pass, and who with their noble Saint Bernard DOGS are always on the lookout for belated travellers. When the snow falls thick and fast and the wind blows it in blinding gusts, these dogs are often sent out alone to search for travellers who may have wandered from the path, and their sharp scent enables them to find even those buried under the snow. When they discover a person numbed with the cold or hidden under an avalanche, they run and give the alarm and bring the monks to the place. One famous dog, named Barry, saved the lives of forty persons lost in the snow.

We who see snow every winter can scarcely understand how strange it looks to those who have never seen it before. A little girl from one of the West India Islands cried out, when she saw it falling for the first time, that the angels were emptying all their feather beds on the earth. When Bruce, the celebrated African traveller, was in Abyssinia,

an old man drew him aside one day and told him that when he was a young man he saw something white fall out of the sky, which covered all the earth, and which went away as silently as it came. He did not know that Bruce came from a country where snow was common, and thought he was telling him a wonderful thing.

The word snow is from the Anglo-Saxon *snaw*, snow.

SNOWBIRD, a small bird of the finch family. It is about six inches long and is dark slate-gray above and white below. It is found almost all over the United States; it appears in New England early in April, while the snow is still on the ground, going north to breed, and goes south again in the autumn. The snowbird is fond of grass seed and berries, and its flesh is delicate and juicy. It has a sweet song in summer, but in winter only a chirp.

SOAP, a substance formed by the union of an ALKALI with OILS and fats. The alkalies used are SODA and POTASH, hard soaps being made with soda and soft soaps with potash. The principal fats and oils used are tallow, lard, fish oils, and palm, olive, cocoanut, rape, linseed, hemp-seed, and other vegetable oils.

Soap is made by boiling fat or oils in great kettles with a lye made by mixing water with either caustic soda or caustic potash. Common soft soap, much used by farmers and in cloth factories, is made by boiling tallow or other grease with potash lye made from wood ASHES. Hard yellow bar soap is made of tallow and various oils boiled with soda lye. A little rosin is added after the boiling is done. The soap, which is then soft, is poured into wooden or iron frames to cool and harden, and is afterward cut up into bars. Castile soap and the fine soaps made for toilet use are mostly made with olive oils and soda. They are usually scented with essential OILS, and made into cakes which are stamped in a press. Many kinds of toilet soap are colored, but the purest and best soaps are white. Most of the fine soaps used in the United States are brought from England and France, but excellent soaps are now made in this country.

There are several trees and plants in the world whose berries, juice, or bark are as good to wash with as real soap. In the West India Islands and in South America grows a kind of tree whose fruit makes an excellent lather and is used to wash clothes. The bark of a tree that grows in Peru, and of another one that grows in the Malay Islands, makes a fine soap; and in California there is a plant whose bulbs are used in the wash tub just as we use soap. When these bulbs are rubbed on clothes a thick lather is made, which smells like that of new soap. The juice of the soapwort and of some other plants is also used to clean with.

The word soap is from the Anglo-Saxon *sape*, from the Greek *sapon*, soap.

SOAPSTONE, or **TALC,** a soft mineral, commonly pearly-gray, but sometimes white, whitish-green, and grayish-green. There are large quarries in Massachusetts, Vermont, New Hampshire, Maryland, Virginia, and other States. Stoves, ovens, and hearths are made of it; and it is used for slate pencils and crayons, by glaziers for marking glass to be cut, and by chemists for the stoppers of vessels for holding acids. French chalk, used by tailors to mark on cloth with, is a kind of soapstone; and the powder used by shoemakers to dust the inside of boots with to make them go on easily is made of ground soapstone. Powdered soapstone is mixed in soap, in flour, in sugar, and in grease for lubricating machinery. In England it is put into paper to give it body, and into cotton cloth made for China and other Eastern countries to give it weight. It is used also in imitat-

ing engraved stones, being easily cut and afterward hardened by heat and changed to any color by the use of metallic washes. It is, too, the base of most of the face powders and tooth powders in use.

The word soapstone is made up of the Anglo-Saxon *sape*, soap, and *stan*, stone, and the mineral is so called from its soapy feel.

SODA, sodium oxide, one of the principal ALKALIES. If the metal SODIUM be kept in the air it will quickly unite with the OXYGEN and form sodium oxide. But that which is commonly called soda is properly sodium carbonate, which is made up of sodium, oxygen, and CARBON. It was formerly made from the ashes of sea-weeds and sea-shore plants. There was once a large trade in crude soda called barilla, made from the ashes of a plant that grows on the sea-coasts of Spain and France, and in a poorer kind called kelp, made from the ashes of sea-weed on the coasts of England, Scotland, and the Shetland Islands; but carbonate of soda is now made almost entirely from common SALT (sodium chloride). Soda is largely used in making GLASS and SOAP, and in washing, both in cloth factories and in dwellings. Housekeepers usually call it washing soda. The soda used by soap-makers is caustic soda (sodium hydrate), made by mixing sodium carbonate with boiling water and then pouring into it slaked LIME and water. The CALCIUM of the lime seizes on the carbonic acid in the sodium carbonate and forms calcium carbonate, which sinks to the bottom, leaving the caustic soda mixed with the water. This is then boiled down until the water passes off as steam, leaving the white soda by itself. The soda sold by grocers and used by cooks in making bread, cake, puddings, etc., is commonly called cooking soda or bicarbonate of soda (hydrogen sodium carbonate). If crude soda (sodium carbonate) be melted in hot water and cooled in shallow pans, large soda crystals will be formed, and if these crystals be then put where carbonic acid gas can get at them they will take up enough of it to turn the crystals into bicarbonate of soda, a white powder which contains twice as much carbon as sodium carbonate or crude soda. By mixing almost any acid or acid salt with bicarbonate of soda this carbon will be turned into carbonic acid, and pass off as gas. Cooks mix with it, in making bread, a little cream of tartar (see POTASSIUM) which sets free the carbonic acid gas, and this puffs up the dough and makes it light. Rochelle powders or Rochelle salts, taken like seidlitz powders as a medicine, consist of bicarbonate of soda in one paper and cream of tartar in another. When the two are mixed in water the carbonic acid is set free and the liquid foams up like SODA WATER.

The word soda is the same in German, Italian, Spanish, and Portuguese. In French it is *soude*.

SODA WATER (so called because first made with soda), a mineral water made of CARBONIC ACID and water, and flavored with various kinds of syrups. Its common name has now no meaning, because the soda water of the present day has no soda in it. Carbonic acid will mix with water at the common heat and pressure of the air, but if the heat be lessened and the pressure be increased much more of it can be got into water than at the common pressure. In making soda water the carbonic acid is got by pouring weak SULPHURIC ACID over marble dust (CALCIUM carbonate). This sets free the gas, which is then forced with a force PUMP into the water in a very strong, air-tight vessel. The water, thus filled with the gas, is then drawn off from the vessel in which it was mixed into smaller ones called fountains, which are sent round in wagons to the various places where soda water is sold. Some fountains are made

of cast-steel on the outside and of tin on the inside, and others are lined with glass, so that the water in them is kept much purer than in the copper fountains once used. Most apothecaries, and others who sell soda water, have handsome marble cases in which the syrups are kept in glass tanks. There is also a place to set the fountain in, where it is kept surrounded by ice, and the water is drawn from it through a pipe leading to the front of the marble case. The soda water is thus kept very cold. Many American soda water fountains have been sent to Europe, and they are now much used in all the large cities.

SODIUM, a METAL, one of the principal ELEMENTS. When pure it is silvery-white, very bright, lighter than water, and at common heat soft as wax. It is never found by itself, as it has such a liking for OXYGEN that it will unite with it if left where it is and form sodium OXIDE, a white powder commonly called soda. Therefore it can never be left where the air can get at it, nor be kept in water, but has to be kept in rock oil, which has no oxygen in it. If a small piece be thrown on to water, it will swim around, just as POTASSIUM does, and unite with the oxygen, setting the hydrogen free, though the heat will not be enough to set fire to the hydrogen; but if the water be hot the hydrogen will take fire and burn with a bright yellow flame. The metal sodium, which was first separated from soda in 1807 by Davy, is very useful to the chemist, who makes it by taking away the oxygen from soda. The salts of sodium are of great importance to mankind and are much used in the arts. Among the most important are common SALT (sodium chloride), which is made up of sodium and CHLORINE; Glauber salts (sodium sulphate) made up of sodium and SULPHURIC ACID; washing SODA (sodium carbonate), made up of sodium and CARBONIC ACID; and Chili saltpetre (sodium nitrate) made up of sodium and NITRIC ACID.

The word sodium is New Latin, and is made from SODA.

SOLDER, an ALLOY which when melted is used as a cement to fasten together pieces of metal. There are many kinds of solder, used by different metal workers, such as jewellers, coppersmiths, tinsmiths, and plumbers. Nearly all the common metals are used in making the different kinds, but the solder most used is made of tin and lead. This is the kind used by tinsmiths and plumbers. Coppersmith's solder is made of zinc and copper, and that used by silversmiths, of silver and copper. In soldering, the edges of the metals to be put together must be well cleaned and heated hot, and the solder, which is laid on them, is then melted with an iron called a soldering iron. Sometimes a little borax or resin is needed to make the solder stick to the parts of the metal, as it keeps the metal from oxidizing (see OXYGEN). Anything used for this purpose is called a flux. The BLOWPIPE is often used in soldering.

The word solder is from the Latin *solidus*, solid, from *solidare*, to make firm or solid.

SOLE, a kind of flat-fish common on the northern coasts of Europe. The flesh is white and firm, and it is one of the sweetest of food fishes. Great numbers are caught in trawl nets along the sandy shores of Great Britain. The average weight is about a pound. The fish called sole in the markets of New York is a kind of flounder, for the true sole is not found on our coast.

California Sole, also a kind of flounder, is largely caught by the Chinese of the Pacific Coast and dried. There are several varieties, all of which are good eating, but not equal to the European sole.

The word sole is from the Latin *solea*, sole, from *solea*, a sandal, probably from its flatness or shape.

SORGHUM, a cane-like grass,

about as tall and much like broom-corn. It is sometimes called also sorgho, and sometimes Chinese sugar-cane. It has been cultivated from very early times in China and in Africa, especially in Egypt, where several kinds are grown, both for the seed, from which flour is made, and for its sweet juice. In 1856 some of the seed was brought to the United States, and it is now cultivated in many States for the juice, which is made into syrup and molasses. Many attempts have been made to make sugar of it, but it does not pay. The seeds are fed to poultry, cattle, and hogs, and the refuse of the stalks is made into coarse wrapping paper.

The word sorghum or sorgho is probably of East Indian origin.

SOUND. If you pull and let go the string of a violin or guitar you will see it vibrate (Latin *vibrare*, to move backward and forward), that is, tremble or quiver, and you will hear a sound. In like manner, when a bell is struck by its clapper, it vibrates. Neither the string nor the bell moves out of place, but only the particles of which they are made up vibrate backward and forward. Now, vibrating motion has power in it and can give a blow as well as the motion which moves from place to place. If you put your finger against a vibrating string or wire you will feel a series of little blows. If you do not put anything against the string it will give the same blows to the air, and will continue them until the vibrations stop. Thus, a vibrating body gives in a short time a great many little blows to the air; and every time the air is hit it strikes the air next to it, and this in turn strikes the air next to that, and so on until the air over a great distance has been hit and put into motion. By and by the blow reaches our ears and we feel it, but not in the way that we would feel a blow from a stick: therefore we do not call it a blow, but say that a sound has struck our ears. This is the way that all sounds are brought to us. The thing which makes the noise strikes the air, and the part of the air struck gives the blow to the part next to it, and so on, and this makes a series of waves through the air, which finally strikes the drum of our EAR, and then we hear a sound. Thus, there is really no such thing as a sound outside of our ears, but only sound waves, which do not make any noise until they strike a blow on the drums of our ears. If we try to ring a bell in a place where there is no air, such as the receiver of an AIR-PUMP, there will be nothing for the vibrating particles of the bell to strike, and no sound will come to our ears. We can see the clapper strike the bell, but we hear no sound. On the top of very high mountains, where the air is thin, sounds are not nearly so loud as in lower places. It is said that a pistol fired on the top of Mont Blanc makes no more noise than a fire-cracker. A person in a room which has all the windows and doors shut can hear a sound made at a distance outside of the room, because the waves of air caused by the sound strike the windows, doors, and walls and make them vibrate, and these vibrations make other waves in the air inside the room, which finally reach his ears.

When a person speaks or sings sound waves are made in the air in the same way as by a violin or guitar string, which is pulled and let go. There are two little flat chords in our throats, stretched across a kind of box at the top of the windpipe. The air, coming up from our lungs strikes against these chords and makes them vibrate or quiver, and they in turn give the blows to the air, and thus make sound waves which cause sound inside of our ears. The noises of most animals, such as the barking of the dog, the mewing of the cat, and the lowing of the cow, are made in the same way. Fishes do not have such a box in their wind-

pipes, because they live always in the water, and air is needed to make the chords vibrate. Frogs, which live both in and out of water, have one, but they can croak only when their heads are out of water.

When the thing which causes the sound gives but one blow to the air, as when a cannon is fired, but one blow reaches the ear and we call it a noise; but when a series of blows is given, as when a guitar string vibrates, the blows come to the ear one after the other in regular order, and we then call it a musical note. If only a few of this series of blows are struck in a second of time, the musical note will be a deep low one, but if the body vibrates so quickly that it gives the air a great many blows in a second, the note will be high and shrill. Thus, when we hear a low musical note we know that the thing which makes it is vibrating very slowly, and when we hear a high shrill note, we know that it is vibrating very quickly. Musical notes are pleasing to the ear, but noises are unpleasant, and sometimes they do much harm. A large cannon when fired will often cause such strong waves in the air as to shatter panes of glass, and sometimes even the drum of the ear has been broken.

Waves of sound do not travel through the air all at once, as LIGHT appears to do, but take some time. When a cannon is fired at a distance, you see the flash and smoke at once, but the sound does not reach you until after a few seconds. The number of seconds depends on the distance, for sound travels at the rate of about 1100 feet or a little more than one-fifth of a mile in a second. If ten men be placed in a row, each one 1100 feet from the next one, and a gun be fired 1100 feet beyond the first one or No. 1, he will hear the sound in just a second after the firing of the gun, No. 2 will hear it in two seconds, No. 3 in three seconds, No. 4 in four seconds, and so on to No. 10, who will not hear it until ten seconds have passed. All sounds, loud or soft, high or low, travel at the same rate. If this were not so the different notes of music would reach the ear at different times and make only confusion instead of melody.

Sounds will travel also through liquids and through many solids. They will pass through water nearly four times as fast as through air. A blow struck by a hammer on a bell under water has been heard as far as nine miles. If one end of a long wooden beam be scratched with a pin, the sound may be plainly heard by a person who puts his ear to the other end, even if the person who scratches with the pin cannot hear it; and the sound of a railway train may be heard by putting the ear down to the rail when it cannot be heard through the air. Sound will travel through a solid body ten to sixteen times as fast as through air. Electricity will reproduce sound waves at a distant place, as is told about under TELEPHONE.

When sound waves strike against any smooth hard surface, they will be reflected, that is, they will spring back just as a rubber ball will when thrown against a wall. For example, if you stand in the middle of a place surrounded by high cliffs and fire a gun, you will hear the report of the gun at once, because the gun is close to you, but soon you will hear something else; the sound waves will spread out until they strike the cliffs, and being unable to go any further will bound back and return to you, travelling always about 1100 feet in a second. In a few seconds the waves of sound will come back to your ear, and you will hear the report of the gun again, just as if another gun had been fired. This second sound is called an echo. Sometimes sound waves bound back from several different places, some further off than others, and then we hear two or three echoes; and some-

times an echo itself is bounded back so as to make a second and a third echo. When a cannon is fired among mountains many echoes are often heard, sounding much like rolling thunder.

If sound waves can be kept together so that they cannot spread out and waste their force in the air, they may be made to go a great distance. They can be thus kept together in speaking-tubes, which are long tubes of small width put into the walls of buildings so that people on one floor can talk easily with those on other floors. When a person speaks in one end of the tube the sound waves are kept in the tube, and thus keep most of their force until they come out of the other end (see TRUMPET).

The word sound is from the Latin *sonus*, sound.

SPARROW. The principal sparrows of the United States are the song sparrow and the chipping sparrow, commonly called chip bird or chipping bird from its notes, which sound like "cheep-cheep-cheep." The song sparrow, which is reddish brown with gray and dark brown marks, has a sweet song and sings all day long. It goes south in the autumn, and returns early in the spring. The chip bird, which comes later, is rather smaller, and is grayish with black markings. It builds its nest in trees, and lays four or five greenish blue eggs. It is very social in its habits, and is seen around dwellings oftener than the song sparrow.

The **House Sparrows** of Europe, the little birds seen in many of our city parks, differ somewhat from our sparrows. They were brought to the United States from Manchester, England, in 1856, and set free in the following spring in Brooklyn, New York. They have increased so fast that they are now to be found in many towns and cities. Their food is chiefly seeds and buds, but they feed their young on larvæ (see INSECTS) and are useful in killing caterpillars on trees; but they are quarrelsome little fellows and drive away other sparrows, as well as robins and bluebirds. Like the chip bird, they build their nests in trees and lay four or five eggs.

In New York City the trees were being cut down because the cankerworms swung on their webs so thickly from them that persons often had to walk in the middle of the street, but the sparrows were sent for and soon remedied the evil.

The sparrow belongs to the order *insessores*, or perching BIRDS, and to the finch family.

The word sparrow is from the Anglo-Saxon *spearwa*, sparrow.

SPECTACLES. The ancients had no spectacles. Roger Bacon, an English scholar of the thirteenth century, is said to have first pointed out that old persons with weak eyes would see letters better by reading through a plano-convex LENS; but the credit of first showing the world how to use spectacles is given to Alessandro di Spina, an Italian monk who died in Pisa in 1313.

Spectacles are used both to assist sight and to protect the eyes from injury. The eye is a camera, as is told about in the article EYE, and if all the lenses are not just right and in good order the image is not formed properly. For example, in near-sighted persons the lenses are too convex or round, so that the rays of light come together into a point before they reach the retina, and the image is thus formed in front of instead of on the retina; in far-sighted persons the lenses are too flat, and the rays, which would come to a point behind the retina if they were not stopped by it, make a blurred image on the retina. What is wrong in the lenses of the eye is made right by the use of spectacles or eye-glasses, which are spectacles in another form.

Near-sighted people are helped by the use of glasses with concave

lenses, and far-sighted ones by convex lenses. Old people, too, use convex glasses, which magnify or enlarge objects looked at near at hand. Sometimes spectacles are made with divided glasses, one part for looking at distant objects, and the other for examining objects near the eye. Spectacles with colored lenses, as blue, green, or smoke-color, are used to protect the eyes from the glare of light, especially on the sea-coast and on ship-board.

The word spectacles is from the Latin *spectare*, to see.

SPECTROSCOPE. In the article LIGHT is told that Sir Isaac Newton was the first to find out how to separate white light into the different colors of which it is made, by passing a ray of sunlight through a prism. The band of light thus obtained, showing seven colors, is called the spectrum (Latin *spectrum*, a spectre, apparition, or image) of sunlight. Every kind of light has its own spectrum, differing in certain respects from that of any other kind of light. The spectrum of the light of burning sodium, for example, consists of a narrow yellow band; and that of burning potassium of two bands, one red and one violet; and so on through all the substances of which the earth is made up, the light of each having its own peculiar spectrum. These bands, too, always occupy certain positions in relation to one another, so that, when looked at through a prism, the yellow band of sodium will be seen in its place and the red and violet potassium bands in their proper places. Thus, by examining the light of different things, it is possible to tell of what ELEMENTS those things are made up. This method of examining things, which was first proposed by Professor Gustav Robert Kirchhoff of Germany, is called spectrum analysis.

The instrument used for observing the spectra of different lights is called the spectroscope. In its common form this consists of a tube with a slit at one end for the light to enter, and at the other end a lens for it to pass through so as to strike a prism properly; the light coming from the other side of the prism is the spectrum, which is looked at through a telescope whose lenses magnify it so that it may easily be examined. There is generally also a third tube containing a scale which is reflected in a certain way into the telescope, so as to give the means of comparing the spectrum with it.

By means of the spectroscope the smallest quantities of some of the elements may be detected, and several new elements unknown before, such as rubidium, thallium, indium, gallium, and others, have been discovered by its means. Through its aid we are able to tell, by examining their spectra, of what the sun, stars, comets, etc., are made of. Thus, we know that at least half of the elements known on the earth are to be found in the SUN.

The word spectrocope is from the Latin *spectrum*, and Greek *skopein*, to view.

SPIDER. Spiders are like INSECTS in being air-breathing, but are unlike them and like the CRUSTACEANS in having the head and chest united in one so that the body, instead of being divided into three parts, as in insects, is divided into but two, the head and chest, and the abdomen. They have also eight legs, while insects have but six, and they have no wings and no antennæ or feelers. Spiders, too, do not pass through two or three changes in life, like many insects, but are born in the same shape in which they grow up.

There are a great many kinds of spiders, and they differ in size from that of a grain of sand to several inches wide. Some are found in all parts of the world, and some only in a few places. Some live in the fields, and some on the water; some live all the time in houses, either in cellars, corners of rooms, or chinks in walls, and others sel-

dom enter houses unless driven in by cold weather.

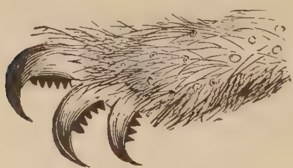
Spiders are flesh-eaters, and their mouths are therefore made for biting, though they generally suck the juices from the bodies of their prey instead of eating them. They are armed with terrible jaws made up of two sharp-pointed hooked blades, with saw-like edges. The points of these blades shut together in the wound when a spider bites, and at the same time there is spirted from them a colorless poison which kills insects. The bite of a spider on the back of a man's hand has been known to cause the whole arm to swell up to a large size; but there are believed to be no spiders in the United States whose bite will kill a healthy man. Spiders usually have eight simple eyes, but a few kinds have six, and a few only two. There is also a kind in the Mammoth Cave, Kentucky, which has no eyes.

Most spiders spin webs, usually called cobwebs, but while some live in them, others use them only as traps to catch their prey. They seldom move, too, from place to place without spinning a line after them, by the use of which they are able to drop safely from any height, and while hanging by it are often swung by the wind across wide spaces without any trouble on their part except to let out the thread. Spiders also line the crevices in which they pass the winter with a coating of silk, and they shut up their eggs in a cocoon of the same material, in which the young remain until they are strong enough to take care of themselves. Although both sexes spin, most of those usually seen in and near webs are females and young spiders, who seldom go far away from them. The grown up males are seldom seen building webs; they hide themselves during the day and wander around from web to web at night.

Spiders spin their threads from the back part of the body, while caterpillars spin theirs from the head. What looks to the naked eye like a single thread is seen, under the MICROSCOPE, to be made up of hundreds of small strands. Inside the spider's body are bags filled with a gummy substance, out of which these strands are drawn through several knobs, called spinnerets, each of which is full of tubes so small that it is said a thousand of them take up no more space than the point of a pin. All these little gummy strands, which dry as soon as they reach the air, come together, just outside the spinnerets, and form one thread, which is guided by the hind feet as it runs out of the body. When the spider begins to build a web it presses the spinnerets against the place where the first thread is to start from, and thus fastens the ends of the strands of which the thread is to be made. After running a few threads along the sides of the places to which the web is to be fastened, it begins the web by carrying one or two lines across where its center is to be. Lines are then spun from the centre to the sides in all directions, and when these are done the spider begins near the centre and spins a thread spirally, or round and round, fastening it to each cross thread as it passes, until it reaches the outside, the spirals being as far from each other as the spider can reach. All the thread spun up to this time is dry, but now the spider spins a final circle on the outer side of the web and covers it as it goes with a sticky matter, strung along on the threads like beads. It continues to spin thus back toward the centre again, using the dry threads first laid as a scaffold to walk on, destroying them as it goes, and replacing them with sticky threads. A few of the first or dry threads are left around the centre, and on these the spider places itself, always with the head downward, and waits for its prey. If an insect now touches one of these sticky threads it is held fast, and its struggles only entangle it the

more. As soon as the spider feels any movement, it runs out to the victim, seizes it in its jaws, and as soon as the insect begins to feel the poison of its bite, it covers it with a silken net and hangs it up to suck at its leisure.

In spinning its web the spider keeps the threads from tangling with its feet. The foot of a spider has three claws, which are toothed like a comb, as can be seen in the picture, where a foot is shown much enlarged. It is supposed that the



Foot of Spider, Enlarged.

threads are made to run through these combs, and are thus kept separate from each other. The claws are also used to take off from the web any dirt or other thing which may get on it. If the dirt cannot be easily got off, the spider breaks off the part of the web on which it is, makes it up into a ball and throws it away, and then spins that part over again.

Spiders may often be seen spinning a thread which they let float in the air, so that the end may be carried by the wind against something and stick to it. A spider thus spinning will often turn round and try the thread to see if the other end has caught, and if it finds it has, it will run out on it just as it would on a thread which it has itself carried and fastened. By this means spiders travel from one high place to another and even cross streams.

Although all spiders spin, they do not all make webs like the house spider: some weave silken tubes in which they dwell, and some, called wandering spiders, have no fixed home, weaving only threads to catch their prey. Some, called mason spiders, build nests of clay under ground and cover the sides with a thick web, the entrance being fitted with a door hung on a kind of hinge; and others build houses of leaves in the woods and spread their nets to catch their prey in front of their doors. There is in Europe a water spider, which lives under water, where it makes its nest and cocoon, which is kept filled with air.

Spiders lay eggs but once a year, usually in June. Almost all kinds enclose them in a cocoon, in which the young remain until they are old enough to take care of themselves. As many as two thousand eggs are sometimes laid in one cocoon, and though many of them hatch, but few live to grow up.

Spiders form the second class of articulate ANIMALS. This class is also called *arachnida*, from the Greek *arachne*, a spider.

The word spider is from the Anglo-Saxon *spither* or *spinther*, a spinner, from *spinnan*, to spin. The word cobweb is from the Old English *cob*, spider, and the Anglo-Saxon *webbe*, something woven.

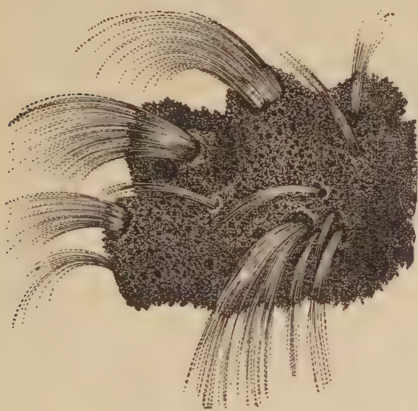
SPINACH, a garden plant, the leaves of which are boiled and eaten as a vegetable. It is supposed to have first been grown in Persia, and to have been brought by the Arabs into Spain, whence it was carried into other parts of Europe. It was unknown to the Greeks and Romans, and was not used in Europe until about the sixteenth century.

The word spinach is thought by some to be from the Latin *spina*, a thorn, the plant being named, as some think, on account of its prickly leaves; and by others from Hispania, the ancient name of Spain; but it comes, more probably, from *ispanaj*, its Persian name.

SPINNING WHEEL. See COTTON.

SPONGE. Sponges were long thought to be vegetables, but they are now known to be animals.

They differ much in form, some being cup-shaped, some pear-shaped, and some having many branches. They grow mostly at the bottom of the sea, on rocks, to which they are fixed by a kind of roots, some in deep and some in shallow water, and generally in pieces from the size of an egg to that of a man's head. In cold climates they are usually small, but in hot climates they are very large and plentiful. When first taken out of the water sponges are dark-colored and look like beef liver. They are made



Sponge.

up of a jelly-like substance, and of a framework of tough fibres. This framework, which is really the skeleton of the sponge, is what is commonly called sponge. When looked at through a MICROSCOPE it is seen to be made up of fine fibres laced together so as to form a great number of holes, some of which are large and some very small. When alive all this part is covered with the jelly-like substance, which becomes sticky when taken out of the water. The sponge gets its food from the water which washes into it. This water is all the time pouring out of the holes in the way shown in the picture.

The sponges of commerce are brought mostly from Turkey and the West Indies. The finest come from off the shores of Candia or Crete and Cyprus, where they are got chiefly by diving. The divers go out in boats and are let down to the bottom by ropes with a heavy stone at the end. When a diver finds sponges he tears them off the rocks, puts them under his arms and then pulls at the rope as a signal to his companions to draw him up again.

Large numbers of sponges are brought also from the Bahama Islands, where they are usually torn from the bottom by means of a hook on the end of a long pole. When the water is too deep the sponge fisherman will sometimes dive for a good sponge, but not often. He has a kind of spy-glass made of a wooden cone covered with glass at one end and open at the other. By putting the glass end just under the water and looking in at the open end he can see the bottom clearly and select the sponges to be hooked up. Sponges from the Bahamas and from the coast of Florida are much coarser than those from the Mediterranean.

They are usually buried in dry sand for a time until the jelly part decays, and then put in wire cages into sea-water until they are washed clean.

The word sponge is from the Latin *spongia*, Greek *spoggia*, sponge.

SPRUCE, a cone-bearing evergreen tree, belonging to the same family with the pine. The principal wild spruces in the United States are the black and the white spruce, which grow in all the cool parts. Their wood, which is very strong and light, is used in ship-building, especially for masts and spars. Good shingles are also made from it. Spruce beer is flavored with the

tender shoots of the black spruce. The Norway spruce, so well known as a beautiful evergreen, was first brought from Norway.

The word spruce is from the Old English *pruse*, Prussian, and the tree was so called in England because masts made of it were first brought from that country.

SQUASH, the fruit of a plant of the GOURD family, to which the pumpkin and melon also belong. Squashes were cultivated by the American Indians before the whites came. Summer squashes do not have so long vines as those raised for winter use, and are generally called bush squashes. The chief kinds are the round flat ones with scalloped edges, called in the Southern States cymblings, or cymlings, and the crook-necks. The best winter squashes are the Boston marrow and the Hubbard. The mammoth squash grows to a great size. One shown in New York in 1884 weighed 223 pounds, and even larger ones have been grown in England.

The word squash is shortened from the Massachusetts Indian word *askuta-squash*, vine-apple.

SQUAW BERRY. In New England the fruit of the WINTERGREEN is sometimes called squaw-berry, but in Utah, Arizona, Southern California, and New Mexico the name is given to the fruit of a shrub five to eight feet high, out of the twigs of which the Indians make their baskets. This fruit, which is red and very sour, is gathered in the summer in great quantities by the Indian squaws, and is eaten both fresh and dried. A very pleasant drink also is made by washing the berries in water. The twigs, which are tougher and more durable than willow, have a peculiar scent which never leaves articles made of it. Baskets made of them are very strong, will hold water, and are even used to cook in, hot stones being dropped in from time to time until the food is done.

SQUIRREL. Squirrels are found in almost all parts of the world, excepting Australia and the West Indies. They are pretty and graceful little animals, with long bushy tails which are generally carried over the back, and are very nimble in their movements. They have large full eyes, small pointed ears, and long whiskers; and five toes on the hinder feet and four toes and a kind of thumb on the fore feet, all armed with strong sharp claws. Most of their time is spent in trees, which they run up with great ease, leaping from branch to branch and often from one tree to another. They can jump from a high branch to the ground without harm, because they spread out their legs and tail when they fall, and these catch the air and hold them up (see FLYING SQUIRREL). Squirrels live chiefly on acorns and nuts, but they eat also the bark, leaf-buds, and tender shoots of trees, and sometimes rob birds' nests, eating both eggs and young birds. In cold countries they lay up a store of food for the winter, not only in their nests, but in holes and nooks near by. The nest is built of twigs, dry leaves, and moss curiously woven together in the hollow or crotch of some old tree; but the CHIPMUNK digs its nest in the ground.

The **Gray Squirrel** is the most common kind in the United States, being found in almost all the States. It is usually gray on the back and whitish below, but black ones are occasionally seen. It has four to six young, born in May or June. They are easily tamed, if taken from their nests when small, and are often kept as pets in wheel- or turn-about cages; but these are very uncomfortable things and keep a squirrel in misery by making him run up a hill which is all the time sliding out from under him. A pet squirrel should be kept in a cage at least six feet long and four feet high, or large enough for a good sized boy to get

into, fitted with perches like the branches of trees, and a neat little box into which it can creep to have a quiet sleep. Care should be taken to keep this clean, and the food box and water dish, which should be of glass, should be kept clean also. Squirrels should be fed on nuts, such as walnuts, hickory nuts, filberts, almonds, and beech nuts. They like milk also, and will eat bread and milk with pleasure. Squirrels may be made very interesting pets if care be taken in training them, and they may be taught to know and love their master, and to come at his call.

The **Red Squirrel** is nearly as common in the Northern and Middle States as the gray squirrel. It is called also the pine squirrel from its love of pine seeds, the chickaree from its loud chatter, and the Hudson Bay squirrel. Its fur is mixed black and rusty-gray above and whitish below. Red squirrels are industrious little fellows and livelier than gray ones, but are less gentle and not so easily tamed. Gray squirrels lie in their nests in very cold weather in a kind of numb state, but red squirrels run around all winter long, and they therefore lay up a good deal more food in the autumn than gray ones.

In some parts of the United States squirrels are so plentiful that they destroy whole fields of wheat and corn, and farmers have great trouble in getting rid of them. In California many thousands have been killed on one farm in a single season. A great many are killed for their furs, which are worn by women and children as trimmings and linings for clothes. Sometimes the fur is dyed to look like sable. The tails are used in making boas and artist's pencils.

The squirrel is a MAMMAL of the order *rodentia*, or gnawing animals.

The word squirrel is from the Latin *sciurus*, Greek *skiouros*, shadow-tail, which is from *skia*, shade or shadow, and *ourd*, tail.

STAFF, a kind of artificial stone, used for covering and ornamenting buildings. It is made chiefly of powdered GYPSUM or plaster of Paris, with a little cement, glycerine, and dextrine (see GUM), mixed with water until it is about as thick as molasses, when it may be cast in moulds into any shape. To strengthen it coarse cloth or bagging, or fibres of hemp or jute, are put into the moulds before casting. It becomes hard enough in about a half hour to be removed and fastened upon the building in construction. Staff may easily be bent, sawn, bored, or nailed. Its natural color is murky white, but it may be made of any tint to resemble any kind of stone, and may be painted and gilded. It is fire-proof and water-proof and if cared for will last a long time, as it may be easily repaired with a trowel and a pailful of the mixture.

Staff was invented in France about 1876 and was used in the construction and ornamentation of the buildings of the Paris Expositions of 1878 and of 1890. It was also largely used in the construction of the buildings of the Columbian Exhibition at Chicago in 1893. Without this cheap and easily worked material the great and splendid buildings at Chicago would have been impossible, for they are little more than skeletons of iron and timber covered with staff. All the beautiful columns with their elaborate capitals, the pediments, friezes, and other ornaments, and even the statues and great statuary groups were covered with staff.

STAG. See DEER.

STARS. The shining bodies which we see in the sky at night may be divided into planets and stars. The planets belong to the solar system (see UNIVERSE) but the stars are all outside of it. Stars twinkle, but planets shine with a steady light. In ancient times the stars were called fixed stars, because they do not move from each other in the heavens, and the name is still given

to them. This was to distinguish them from the planets, which are all the time changing their places. But while the stars keep the same places in regard to each other, they look as if they had a regular daily motion. Most of them appear to rise in the east and set in the west, but they do not really move in that way, and only look so because the earth is all the time turning round. It is known, however, that some of the stars really move, and it is supposed that all are in motion, some going along in a path and some turning round each other.

Some of the stars look much brighter than others. We do not know exactly why this is, for we cannot tell whether some are really brighter than others, or whether some only shine brighter because they are larger or are nearer to us. In the best TELESCOPES the brightest stars do not appear, like the planets, as globes, but only as little points of light. It is therefore impossible to tell how large they are, or how far off they are; but it is thought that none of them are smaller than our sun, and that many of them are several hundred times larger. It is probable that each one of them is a sun like our sun, and is the centre of a system of planets like our own. The distance of a few of the ones nearest to us has been measured and found to be more than five hundred thousand times as far as our sun is from us. This is the reason why they look so small to us, and why we cannot see their planets even with the strongest telescopes.

The stars are not only of different brightnesses, but are also of different colors. This can be seen better with a telescope than with the eye alone. Some look white, others yellow, orange, red, green, blue, lilac, olive, and gray. Some stars are double, that is, two stars are so close that one turns round the other; and sometimes there are more than two turning round each other. In some cases each of the stars is of a different color, so that if they have planets rolling round them, as our sun has, their planets would have two suns, each giving different colored light.

The stars are divided by astronomers into classes according to their brightness. These classes are called magnitudes, the brightest ones being said to be of the first magnitude, the next brightest of the second magnitude, and so on. There are only about 20 stars of the first magnitude, 65 of the second, 190 of the third, 425 of the fourth, 1100 of the fifth, and 3200 of the sixth; while of the ninth magnitude as many as 142,000 have been counted. Stars of the sixth magnitude give so faint a light that only the best eyes can see them, and those beyond this magnitude cannot be seen without a telescope. When we look up into the heavens the stars appear to be countless, but we can really see only about 3000 with the naked eye on the clearest night. But it is very different when we look through a telescope, for we then see millions of stars which give too faint a light for our eyes alone to take in. The band of whitish light stretching across the sky, usually called the Milky Way, is seen to be made up of countless numbers of small stars, which appear to be so close together that they look like a mass of light; but they are not really close together, and only look so because they are so far away. There are also clusters of stars scattered over the heavens, made up of thousands of stars so small that they look to the eye only like a dull patch of light, but which are seen through a telescope to be separate stars. Some of these clusters cannot be split up into stars, but still look only like patches of light even through the largest telescopes. These are called nebulæ (Latin *nebula*, plural *nebulæ*, a cloud) to distinguished them from

clusters of stars. Some look like a patch of light with a star in its middle, and these are called nebulous stars. It is not known exactly what the nebulæ are, but some think they are masses of blazing gases which grow smaller and smaller until they turn into nebulous stars; and that the clouds of light around these stars form rings, something like the rings of Saturn, which in time break and make planets. Meanwhile the star in the center gets thicker and hotter and finally shines like a sun, giving light and heat to the planets rolling round it, just as our sun does. Some think that our solar system and all the other star systems grew in this way out of a mass of burning gases, much like the nebulæ which the telescope shows to us.

The word star is from the Anglo-Saxon *steorra*, from the Greek *aster*, star.

STARCH. Most people think of starch only as a substance used by washerwomen for stiffening linen; but it really forms a large part of the food of man. It is in all the vegetable substances that we eat, and especially in the grains used for food, which are largely made up of it. Rice is nearly nine-tenths starch, and Indian corn and barley more than two-thirds starch; rye, oats, and wheat contain nearly as much, and potatoes are one-fifth starch. ARROWROOT and TAPIOCA are kinds of starch made from the roots of plants, and SAGO is starch made from the pith of the sago palm tree.

Starch may be easily made. Scrape or grate a potato to a pulp; mix this with water and squeeze it through a cloth several times. The woody fibre of the potato will remain in the cloth, while the water will have a milky look caused by the starch it carries away. Let the water stand until the starch settles to the bottom, then pour off the water and dry the starch. Wheat starch may be made in a similar way. Mix a handful of flour with water enough to make a thin paste. Put this into a cloth and work it with more water as long as the liquid which runs from it looks milky. Let it settle, pour off the water, and dry the starch as before. The sticky substance left in the cloth after the starch is all washed out is GLUTEN.

Starch looks like a white powder, but if examined under the MICROSCOPE it is seen to be made up of little round or oval grains. These differ in size and looks in different kinds of starch; the grains of potato starch being more than three times as large as those of wheat starch, and ten times as large as those of rice starch. When starch is boiled the coverings of these little grains burst and they swell up into a thick jelly. This is the reason why beans, rice, and other grains swell up when they are cooked.

Starch is made up of just the same ELEMENTS as sugar, that is, of CARBON, HYDROGEN, and OXYGEN; but not in quite the same quantities. Each has in it about the same amount of carbon, but starch has less hydrogen and oxygen in it than sugar. By adding enough of these to make up the difference, starch may be turned into SUGAR.

When dry starch is heated to 205 degrees, or nearly as hot as boiling water, it gradually becomes brown and is turned into dextrine, which differs from starch in many things. When mixed with water it forms a strong gum, sometimes called British gum, used on postage stamps, and also by calico printers for thickening their colors and for stiffening calicoes.

The word starch is from the Anglo-Saxon *stearc*, stark or stiff.

STAR FISH. The common star fish, called sometimes five fingers, and five-fingered Jack, is often seen along the New England coast. It is shaped like a five-pointed star, has a rough upper side, and great numbers of little feet on the under

side, which are hollow and may be used like suckers, so that the animal can walk up the side of a smooth rock in the water. Star fish walk with these over the bottom of the sea and catch their food with them. Their mouth is in the middle of the lower part.

Most star fish have five arms of equal length, but there are some kinds with more arms. Different kinds differ much in color: some being grayish-yellow, some orange-yellow, some reddish, and some reddish-purple. All of them live in the sea, and none in fresh water. If one be taken from salt water and put into cold fresh water, it will die at once. Many are found in shallow water on sandy coasts, but some kinds have been taken from very deep water. They are more plentiful in the seas of hot than in those of cold countries. Several kinds of common star fish are shown in the picture.

Star fish are very greedy, and their sole business seems to be to eat. They live largely on decaying animal matter, thus doing the same service in the sea which vultures and some insects do on land. They feed also on CRUSTACEANS, small fish, and MOLLUSKS. It is said that they eat many oysters, which they force to open their shells by spirting a few drops of a poisonous liquid on their edges. When the oyster opens, the star fish catches it with its arms and swallows it little by little.

Star Fish.

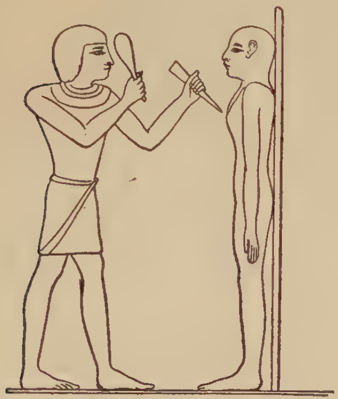
The star fish belongs to the sub-kingdom of radiate ANIMALS.

The star fish gets its name from its shape.

STATUE. There are different kinds of statues, but they are generally either cut with chisels and other tools out of stone, or cast in metal. In beginning a marble statue, it is usual to make a small sketch or design of it in potter's clay, and afterward to make from this a larger one, called the model, which the artist corrects and makes as perfect as he can while the clay is soft.

When this is done it is cast in plaster, but first a mould has to be made. The model is made pretty wet, so that the moisture in the plaster of Paris will not be taken up too quickly by soaking into the clay, and a soft mixture of plaster of Paris and water is spread over it. This is put on in parts, the front of the head and chest being usually first covered. As soon as the plaster sets or hardens, which takes only a few minutes, it is taken off and more plaster

is spread over the back part of the head and chest. Thus the whole body down to the waist is moulded in two parts, and the rest of the mould is made in the same way. Sometimes the whole statue is



Egyptian Sculptor making a Statue.

smeared over with the soft plaster, and cut up into several parts with a fine thin saw after it has set. After the mould is made it is cleaned by brushing it with a soft brush and water, and the parts are fitted together and bound by a cord or rope, the seams being carefully filled up on the inside so as to be perfectly smooth. The mould is then wet with water and a mixture of plaster of Paris and water, made about as thick as cream, is poured in, a little at a time, while the mould is turned round in such a way as to cause the plaster to run all over the inside surface. As the plaster hardens very fast, a thin shell is thus made all over the inside of the mould. When the plaster is well set, the mould is cut off with a chisel and hammer, great care being taken not to hurt the casting inside, which will be an exact copy of the clay model. All plaster busts and figures are made in this way; but if many of one kind are to be made, a second mould is built up from this plaster cast, and so arranged in pieces that they may be taken apart, so as to let the casting out, and then put together again to make another casting.

The plaster cast thus made is used by the artist as a model for his marble statue. All the rough work on the marble is done by common workmen, the sculptor himself putting on only the fine touches which finish it. In cutting the rough block the workmen have measuring tools by which they are able to cut the marble down to the exact shape of the model. After the chiselling is done, the surface is smoothed off with PUMICE or sand.

Metal Statues are usually cast in two to six pieces, the parts being put together afterward and joined so nicely that the seam cannot be seen. This is because the metal is apt to cool unevenly when cast in large pieces, and to crack. The mould for a metal statue is usually made of a kind of fine loam or sand, which sticks together well when pounded. The model of the statue is laid in a strong iron box called a flask, on a bed of loam, and more loam is then packed and hammered tightly in sections or parts all over it. Each section is so made that it can be taken off. This has to be done with the utmost care, and it sometimes takes weeks and even months to make a mould for a full-length statue. Iron rods are put through each section and little channels are made in them for the melted metal to run in. When the mould is done, the sections are taken apart, and the model is taken out. Some of the sections are then again fitted together in the flask, and as they are built up, the middle part, from which the model was taken out, is filled up with loam mixed with a little molasses or paste and rammed down tightly. An iron frame is fitted inside to make it stronger, and one or more tubes are put in to carry off the gases when the melted metal is poured in. When the mould has been put to-

gether piece by piece and the inside all filled up, it is again taken apart, and the middle, which is called the "core," and which is exactly like the model, is taken out, set upright, and its whole surface carefully pared down with sharp tools until enough has been cut to make it so much smaller than the outer mould that when the two are put together again there will be a space about half an inch wide between them, into which the metal is to be poured. Both it and the outer mould are then baked in an oven until dry, when the core is put back into the flask and the mould again built up around it, the core being held exactly in its place by the iron rods which fit into the sections of the mould. When the statue is cast in a single piece the mould is usually set upside down, and the metal is poured into holes in the base. The flask is tightly fastened together with iron bolts to keep the mould from opening during the casting. The metal, which is usually BRONZE, is melted in a furnace, then drawn off into a CRUCIBLE and poured in. When the metal is cool the flask is opened, the mould knocked to pieces, and the core dug out. The statue is now in a very rough state, and has to be chiselled off, filed down smooth, and finally chased with different kinds of tools before it is ready to be set up.

The word statue is from the Latin *statua*, an image or statue, which is from *statuere*, to set up.

STEAM, water in its gaseous form (see ELEMENT). Steam has no color, is lighter than common air, and is invisible, that is, it cannot be seen. The white cloud which you see coming out of the spout of a tea-kettle when water is boiled in it is not steam, but steam turned into FOG. If you look close to the spout of the kettle, you will see a clear space between the end of the spout and the white cloud. The steam is there, although you cannot see it. As soon as it reaches the cool air it condenses, that is, it becomes thick, and the little particles of water form a cloud, just as fog is formed in the air. If the cloud could be caught in a close and cool vessel, it would turn back into water again; but as it floats off it grows thinner and thinner and becomes a part of the moisture of the air.

When water is heated over a fire, the heat has two things to do: first, it has to heat the water, and second, it has to turn the water into steam. The water begins to heat at the bottom, where it is nearest to the fire. As it warms it rises to the top and cool water comes down to take its place: and so it keeps moving up and down till all has become heated. When the water gets very hot, steam begins to be made at the bottom. A simmering noise is heard, and little bubbles of steam begin to rise up through the water. If water be boiled in a glass vessel, you can easily see the bubbles. Soon the bubbles grow larger and larger, as the water gets hotter, and they rise so fast through the water that they make a bubbling sound. We then say that the water boils; so that the boiling of water is only the rising of steam bubbles through it.

Steam is really passing off from water all the time, whether it boils or does not boil. If you lay a wet cloth out in the sun, or hang it before the fire, it dries, that is, the water in it turns into steam and goes off into the air. The water which rises from the ocean, and from lakes and rivers into the air is also steam. But when steam is given out by water which is not boiling, we call it evaporation (from Latin *vapor*, steam or vapor); and it is only when the water is heated enough to make steam rise from its bottom in bubbles that we call it boiling. At the common pressure of the air, water will boil in an open vessel when it is heated so hot that a THERMOM-

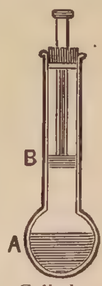
ETER put into it will rise to 212° of Fahrenheit's scale; but if the pressure of the air be made less, it will boil with less heat. On the top of Mont Blanc, which is about three miles high, water will boil when heated only enough to raise the thermometer to 185° F. This is not heat enough to cook with, and a traveller would try in vain to boil an egg at such a height, because, although his water would boil, there would not be heat enough in it to harden the ALBUMEN of the egg. If the pressure of the air be made greater than it is commonly, it will take more than enough heat to raise the thermometer to 212° to make it boil.

Steam is very elastic, that is, it has in it a great deal of springiness. Neither water nor steam can be heated above 212° in an open vessel at the common pressure of the air; but under great pressure the heat of both can be raised very high, and the elasticity or springiness of the steam grows with the heat. When steam is shut up in a tight, strong vessel, like the boiler of a steam engine, and heated, its elasticity may become so great that no vessel can stand the pressure. Many steam boilers are burst by heating steam too much. When a steam engine is going, the steam is used up as fast as it is made, but when the engine stops, the steam collects in the boiler, and the engineer opens the valve and lets out some of it. The noise which it makes in rushing out shows how powerful it is. If this were not done the steam might burst the boiler. Sometimes a boiler is burst in another way. The water in it gets very low, and the fire therefore heats it very hot. If water be then let into it, a great deal of steam is made all at once, so much that the boiler cannot stand it, and it blows up. When water is turned into steam the steam fills about seventeen hundred times as much room as the water did from which it was made. This shows the great strength of steam. When it is shut up it tries to spread out so as to fill this space, and if it is stopped by anything it breaks through it. For this reason it has to be watched very carefully when used in engines, or it will do much damage.

The principal use of steam is to work locomotives and other STEAM ENGINES, but it is also used for heating houses and other buildings, melting solids, heating liquids, and for many other purposes.

The word steam is from the Anglo-Saxon *steam*, vapor or smoke.

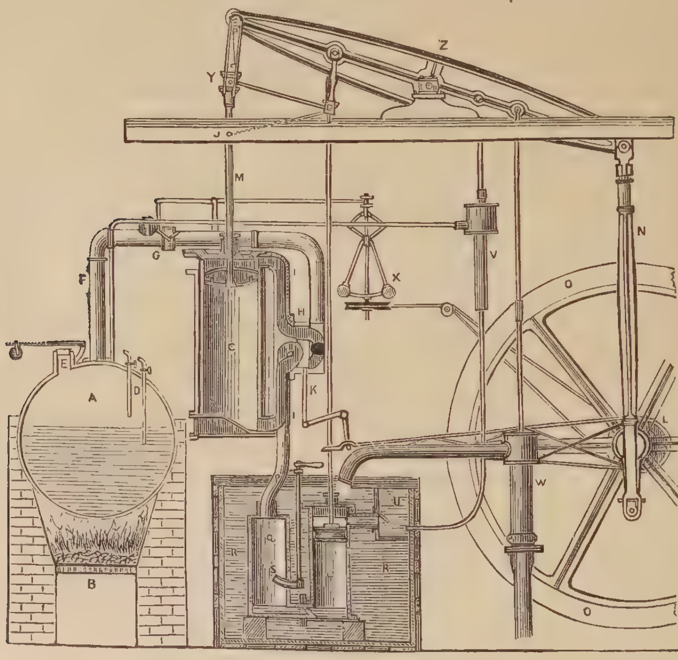
STEAM ENGINE. The principle of the steam engine may be seen in the first picture, which shows a glass tube or cylinder, ending in a bulb, A, and having a piston, B, working up and down in it, but so closely as to be air-tight. Put into the bulb a little water and make it boil by holding a lamp under it. The water will be turned into steam, which will force the piston up to the top of the tube. If the bulb be then cooled in water, the steam will be condensed or turned back into water, and the pressure of the outside air will drive the piston down again. By thus heating the water in the bulb and by cooling it the piston may be forced up and down any number of times. The reason is easy to understand: the steam drives the piston up because it is strong enough to overcome the pressure of the outside air; but as soon as the steam is condensed into water again the space which is filled becomes a vacuum, that is, it becomes empty, and the pressure of the air drives the piston down to fill it. It is just the same in the steam engine, only the piston is forced both ways by steam, which is first let in on one side and then on the



Cylinder and Piston.

other side. You will see how this is by looking carefully at the second picture, which shows a condensing steam engine.

The Condensing Engine, which is so called because the steam is condensed after being used, is still much the same as it was when first made by James Watt a little more than a hundred years ago (1763). In the picture, A is the boiler, which is shaped like a cylinder, that is, long and round like a barrel, and is made of thick iron plates. It is filled about two-thirds full of water, and a fire is made on the grate B under it. The water has to be kept at about the same height all the time, and the engineer can tell whether it is right or not by turning the stop-cocks marked D. One of these ends below the water and one above it. If the water in the boiler is right, steam will come out of the short one



Condensing or Low-Pressure Steam Engine.

and water out of the long one; but if the water is too high, water will come out of both, and if it is too low, steam will come out of both. On the top of the boiler is an opening, in which is fitted a safety-valve, E. This VALVE is fastened to a little rod which has a weight hung on the end of it. The weight keeps the valve in its place until the steam in the boiler becomes so strong that it is able to lift it and then the valve is pushed up and some of the steam escapes. If it were not for the safety-valve many more boilers would burst than we hear about.

The cylinder of an engine is the long, round, tight iron barrel or tube in which the piston works. In the picture the cylinder, C, is cut in two, up and down, so that the inside can be seen. The piston, which

is shown near the top of the cylinder, and which is fastened to the piston-rod M, is fitted into the cylinder so that it will move up and down in it, but so closely as to be air-tight. The piston is moved by steam which comes from the boiler through the large pipe F. This pipe leads the steam into the valve-box, H, from which two curved pipes, I and I, carry it first to the top and then to the bottom of the cylinder. In the valve-box is a valve called a slide-valve (because it slides up and down), fastened to the rod K, which is worked by a piece called an eccentric, going round the shaft or axle of the great wheel at L. By means of this the slide-valve is made to move first down, so as to leave open the upper tube I, at the same time closing the lower one, and then up, as to open the lower one and close the upper one. In this way the steam is first let into the top of the cylinder and then into the bottom of the cylinder.

After the steam has moved the piston either up or down in the cylinder, it passes into the pipe P, which leads into the condenser Q. The condenser stands in a cistern, R, R, filled with cold water, a jet of which passes through the little pipe S, and condenses the steam into water again. As this water is warm, it is pumped by the pump T into the hot-water well U, whence a pipe leads up to the pump V, which carries it back to the boiler. A cold water pump, W, keeps the well full of cold water. All these pumps are worked by rods connected with the working-beam.

The piston rod, M, is connected with one end of the working-beam, Z, and is made to move straight up and down in the cylinder by means of two rods, one of which is fastened at Y, and the other to the frame of the engine at J. From the other end of the working-beam a rod N extends down and turns the crank, which moves the great fly-wheel O O. The fly-wheel is very heavy, being made of iron, and is intended to give a steady motion to the engine, which would move somewhat jerky without it.

It is now easy to understand how the engine works. Let us suppose that the cylinder, C, is full of steam, which has just pushed the piston up in the same way in which it pushed up the piston in the glass tube. The slide-valve now moves down, as shown in the picture. This opens the upper pipe I, so as to let the steam into the top of the cylinder and drive the piston down to the bottom, and at the same time lets out the steam in the cylinder below the piston into the pipe P, which carries it into the condenser Q, whence it is sent back as water into the boiler. The slide-valve then moves up. This opens the lower pipe I, so as to let the steam into the bottom of the cylinder and drive the piston up, letting out at the same time the steam in the cylinder above the piston into the pipe P, which carries it into the condenser, as before. And thus it goes on, the piston being first driven one way and then the other, and the steam above or below it being condensed so as to let the fresh steam act. If the steam should be left in the cylinder after pushing the piston one way or the other, the piston could not be moved again, because this steam would be just as strong as the new steam which the sliding-valve would let in. It must therefore be got rid of, and this is done in this kind of engine by condensation, or turning it into water. In what is called the high-pressure engine, the steam is not condensed, but is let out into the air through a valve each time the piston goes up and down in the cylinder. This is the simplest kind of engine, because it does not need any condenser or cistern of cold water. High-pressure engines are used on railroads and in steamboats on the Missis-

sippi and many other Southern rivers. They are more dangerous than condensing, or low-pressure engines, because they have to use much more steam. When the waste steam is let out of the cylinder the air rushes in and takes its place, and presses so hard against the piston that it takes much more steam to drive it down than in the condensing engine, where, after the steam is condensed, there is a vacuum, or an empty space, on one side of the piston, so that it takes but little fresh steam to drive it down the cylinder.

The governor of a steam-engine is a little machine which governs the supply of steam, that is, lets into the cylinder just the right quantity of steam. In the picture the governor is shown at X. In the pipe, F, which carries the steam from the boiler to the cylinder, is a valve, G, called the throttle-valve, by which the pipe may be opened or closed. A rod connects this valve with the governor, which is made to turn round by a belt from the fly-wheel, and the faster the fly-wheel moves the faster the governor will go round. At the lower end of the governor are two heavy balls so hung that if it goes fast they will swing further out from the centre rod, and if it goes slow they will swing nearer to it. This opens and shuts the throttle-valve G, by raising and lowering the rod which leads from the governor to it, and so the supply of steam is

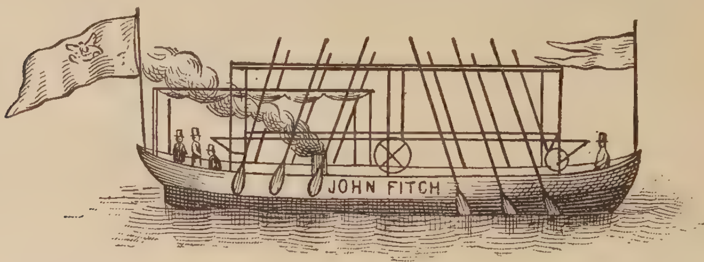


Fig. 1.—Fitch's Steamboat.

regulated. If the engine goes too fast, the balls of the governor swing out, and this pulls on the rod and partly closes the valve, so as to shut off some of the steam ; and if it goes too slow the balls swing inward and thus open the valve and let in more steam. Thus the speed of the engine is ruled by the governor.

The strength of a steam-engine is commonly marked by its horse-power. By one horse-power is meant a force strong enough to raise up 33,000 pounds one foot high in a minute ; this being found to be about what a very strong horse could do working eight hours a day. An engine of one hundred horse-power would be able to do a hundred times as much as this. A steamboat of 1000 tons generally has an engine of 360 horse-power.

STEAMSHIP. Many attempts to propel vessels by steam were made in different countries in the sixteenth, the seventeenth, and eighteenth centuries. In 1786 John Fitch of Philadelphia made a steamboat that worked by means of paddles, as shown in Fig. 1 ; but none of the early experiments were of much consequence until Robert Fulton built the Clermont, launched at New York in the spring of 1807. In the same year John Stevens of New Jersey brought out the Phœnix, which went from the Hudson around to the Delaware River, the first sea voyage made by a steamboat. The Clermont, shown in Fig. 2, was 133

feet long, and 160 tons burthen. She made her trial trip in August, and in September went to Albany, making the 150 miles in about 30 hours. Two other steamboats, the Raritan to run on the Raritan River, New Jersey, and the Car of Neptune, for the Hudson, were built the same year under Fulton's directions; and in 1811 and 1812 the Paragon and the Firefly, both also for the Hudson. All these steamboats, each more than 100 feet long (the Paragon was 173 feet long and 331 tons) were in use before the Comet (only 40 feet long), the first English steamboat, built by Henry Bell of Glasgow in 1812, was run on the Clyde. The first steamboat on the Mississippi was the New Orleans, built at Pittsburg in 1810; and the second the Vesuvius, built in 1814. In 1813 five steamboats were built by Fulton for use on the Hudson, the Potomac, and Long Island Sound: two of them being ferry-boats for New Jersey and Brooklyn; and in 1814 he constructed the Demologos, called after his death (1815) the Fulton the First, the first steam man-of-war ever built. This ship, which carried thirty 32-pound guns, was blown up by accident at the Brooklyn Navy Yard, June 4, 1829.

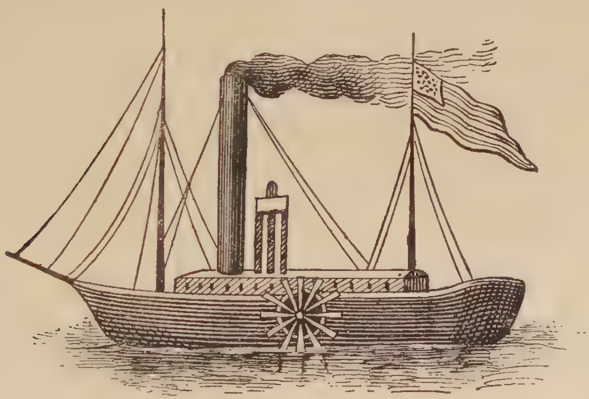


Fig. 2.—The Clermont.

In 1815 a steamer made the passage from Glasgow to London, and in 1818 one went from New York to New Orleans. The first steamer to cross the Atlantic was the Savannah (380 tons), built in New York in 1818 for a sailing packet ship between that port and Savannah. The next year she was fitted at Savannah for a steamship and sailed from there May 26, for Liverpool, which she reached on June 20, 1819. The Savannah (Fig. 3) was a full-rigged ship, with side paddle-wheels which could be unshipped and taken on deck in heavy weather. She burned pine wood, as coal had not then begun to be used on steamers, and made a great smoke. From Liverpool she went to St. Petersburg and returned home in December. Her steam engine and boilers were afterward taken out and she was used again as a sailing packet between New York and Savannah. She was finally wrecked on the south coast of Long Island. The first regularly built steamship was the Royal William, built at Quebec in 1831, which crossed to London in 1833.

The first line across the Atlantic was established by the Great West-

ern Steamship Company in 1838. In that year, April 8, their first steamer, the Great Western, sailed from Bristol; four days earlier, April 4, a rival steamer, the Sirius, had started from Cork, and the two arrived in New York on the same day, April 23. Since that time regular passages across the Atlantic have been made by steamers. The Cunard line was begun in 1840, their first steamer being the Britannia; their first iron steamer was built in 1855, and their first screw steamer, the Scotia, in 1862. Besides the Cunard, there are many other transatlantic lines now running from New York: the Inman, started in 1850, which became in 1892 the International (under the American flag); Hamburg-American, 1856; Anchor, 1856; North German Lloyd, 1857; French, 1862; Guion, 1864; White Star, 1870; Netherlands, 1872; Red Star, 1873; Thingvalla, 1879; and others.

Screw Steamers. The screw propeller was applied to steam vessels in 1838, when John Ericcson built the F. B. Ogden, the first screw steamer. The United States steamer Princeton was the first screw man-of-war. The screw is faster, safer, and handier than the paddle-wheel, and the screw engine is cheaper and takes

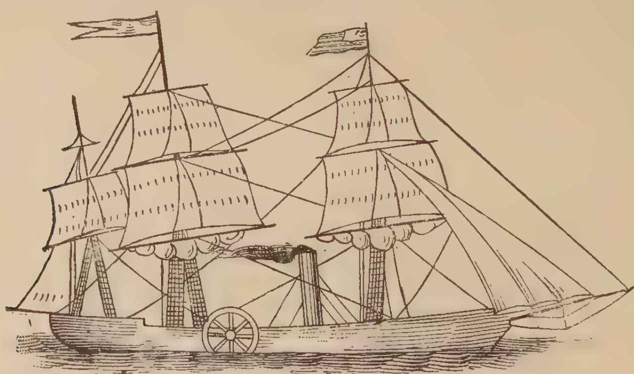


Fig. 3.—The Savannah.

up less room than the paddle engine; but the screw steamer is more apt to roll in a heavy sea, and cannot be started or stopped so quickly as the paddle steamer. But screw steamers are now generally fitted with two screws, one on each side of the stern instead of one in the middle, and this makes them steadier. Each screw is driven by its own engine, so that if the steering gear gets out of order the ship can be guided by the engines; and it is not likely that both engines will break down at once. Paddle-wheel steamers are now confined mostly to rivers and inland waters; all the great ocean lines use screw steamers. On some shallow rivers at the South steamboats with paddles at the stern, instead of on the sides, are used.

When iron began to be used, steamships increased rapidly in size until the building in 1858 of the Great Eastern, which was 692 feet long by 85 broad, with a tonnage of 22,500. Her engines were of 11,000 horse-power, which moved her at the rate of fourteen miles an hour. She had six masts, the second, third, and fourth only being square-rigged. She drew so much water and the expenses of running her was so great that she did not pay as a passenger

steamer, and after being used a while in laying ocean telegraph cables, she was finally broken up. After her, vessels of 5000 tons were constructed; and since steel has been applied to ship-building, passenger steamers of more than 10,000 tons, and war vessels of more than 15,000 tons, have been built.

STEEL, a compound of IRON and CARBON. It has in it a little more carbon than wrought-iron, and a little less than cast-iron; is harder, denser, smoother, finer, and more elastic or springy than iron, takes a brighter polish and does not rust so quickly as iron. It may be made by heating bars of wrought-iron for eight or ten days with powdered charcoal in an air-tight furnace called a cementing furnace. The heat is not strong enough to melt the iron nor to turn the carbon of the charcoal to vapor, but the carbon is thus forced into the substance of the iron, turning it into steel. When taken out of the furnace the bars are covered with blisters, and hence are called blistered steel. Blistered steel may be made into rough articles at once, but for making fine things it must first be hammered. The bars are cut up into short pieces (about eighteen inches), half a dozen of them are bound together and heated red-hot in a furnace, and then put under a tilt-HAMMER, which gives them a shower of blows, welds them together, and makes them into a single bar of smooth, dense steel. This is called shear-steel, because it is the kind used for making shears, and most common cutting instruments. Cast-steel is still finer than shear-steel. It is made from blistered steel by melting it in crucibles in a wind furnace, where a very intense heat is got by letting plenty of air in under the grate. When the steel is melted it is poured out into moulds of cast iron and made into short bars called ingots. It is then ready to be forged and rolled out into thinner bars like tilted steel, but as it is denser and harder more care has to be taken with it.

Bessemer Process. Cast steel is now made in a quicker way by what is called the Bessemer process, because first found out by Henry Bessemer, an Englishman. Cast-iron, first melted in a furnace, is drawn off into a large covered CRUCIBLE called a converter, so swung on pivots that it can be easily tipped up and emptied. Through holes in the bottom of the crucible a blast of air is forced up into the melted metal. This causes a great heat which rapidly burns out the carbon. After about a quarter of an hour a little of another kind of iron is thrown in, and the blast kept up a few minutes longer. When done the metal is poured out into a great ladle, and thence into moulds and made into ingots.

Basic Process. Improvements on this process were made by Thomas and Gilchrist, also Englishmen, who found out that the phosphorus could be got out of iron by lining the converter with what is called a "basic" lining of lime and magnesia. This process of steel making, now much used, is called the "basic process," and sometimes the "Thomas-Gilchrist" process.

The best kinds of cutlery are made from cast-steel, and it is used largely also for casting cannon, and for making rails, bridges, machinery, and ships. Steel is now hardened, toughened, or made more elastic by mixing with various quantities of other metals, such as MANGANESE, TUNGSTEN, ALUMINUM, NICKEL, and CHROMIUM.

The word steel is from the Anglo-Saxon *stéle*, *style*, steel.

STENCIL, a thin plate of metal, pasteboard, or other thin material, with a pattern or letter cut through it, as shown in the picture. When used the plate is laid flat on the surface to be stencilled, and a brush dipped in paint is rubbed over it. In this way patterns or letters are easily

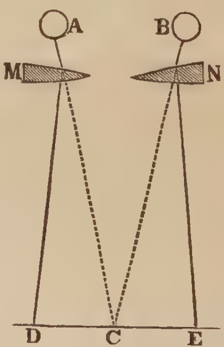
painted on any flat surface. Walls of rooms are thus colored quickly and cheaply. Stencil plates are

Stencil Plate.

much used by merchants for painting names on boxes and barrels. The origin of the word is unknown.

STEREOSCOPE, an instrument by the aid of which two flat pictures appear to our eyes to be united into one, and raised up so as to look solid. When you look at a thing with both eyes, each eye sees differently. For instance, suppose that you are looking at a statue; the right eye sees all the front part and a little of the right side, and the left eye all the front part and a little of the left side. Thus, both eyes together see the front part and a little of each of the sides, and it is by the union of these two images in the eyes that the statue is made to look solid instead of flat. To make a picture of a statue appear real to us, it ought, therefore, to be shown in the two different ways in which it is seen by our eyes. This can be done by taking two photographs of the statue, one from the point from which the right eye would look at it, and the other from the point from which the left eye would view it. These two pictures may look to you to be exactly alike, but they are not, for one is the image which your right eye sees and the other the image seen by your left eye. If now these two pictures can be placed one on top of the other, so that they shall make but a single image in your eyes, this image will appear in relief, or to stand out from the paper so as to look solid, just as the real statue does to your naked eyes. This is done by the stereoscope, which is usually made up of a small box with a place at the back for sliding the pictures in, and two eye-glasses to look at them with. When you look through these eye-glasses the two pictures appear like a single picture placed in the middle between the two, and all their parts stand out from the paper as if they were solid and real.

You will best understand the reason of this by looking at the picture, where D and E are the two pictures at the end of the box; M and N the two eye-glasses; and A and B your two eyes. In the article LIGHT is told that when a ray of light is made to pass through a prism, it is refracted, or bent, toward the thick part of the prism. Now the two eye-glasses are really only prisms, though their surfaces are ground so as to be a little curved or rounding. Rays of light from the picture at D, after passing through the prism M, are therefore bent toward the thick



Plan of Stereoscope.

part and thus go into the eye at A, just as if they came from C, while rays from the picture at E, after passing through the prism N, are bent so as to go into the eye at B, just as if they came from C. Thus the rays from the two pictures reach the two eyes as if they all came from a single picture placed at C between the two real pictures D and E; and this picture has united in it all the different parts of the two pictures so that it looks solid as things do in nature.

The word stereoscope is made up of the Greek words *stereos*, solid, and *skopein*, to see.

STILTS, sticks or crutches to raise the feet up above the ground in walking. Common stilts used by boys are only playthings, but in some countries stilts are much used in travelling. In the southwest part of France are large plains called the Landes, which are often flooded in parts with water, as shown in the picture. In crossing these plains, where the water is not generally deep enough for boats, stilts about five feet high are worn most of the time by both men and women, who thus are able to keep their feet dry. They are not held by the hands, like the stilts used by boys, but are firmly strapped to the side of the leg, and the person wearing them carries a long pole in the hand to balance himself and to aid him in walking. This pole usually has a cross-piece on the upper end, like the head of a crutch, and by putting it at a slant on the ground behind him the person on stilts can sit down on it and rest, looking in this position as if on tripod or three-legged stool. Men and women may often be seen in

Stilts in the Landes.

that country, perched in this way upon high stilts, and knitting while they watch their sheep. They wear their stilts all day long, putting them on when they go out in the morning and taking them off only when they return home at night. So used are they to them that they can travel long distances on them without getting tired; and as they are able to take very long steps they can go much faster than a man on foot. In 1891 a stilt-walker of the Landes, named Sylvian Dornon, walked on his stilts all the way from Paris to Moscow in fifty-eight days.

The stilts are called in the Landes *tchangues* (big legs) and those who use them *tchanguès*. The peasants acquire great dexterity in their use, running with ease and great swiftness, going on one leg, picking a flower or a pebble from the ground, and performing other feats. When the Empress Josephine went to Bayonne in 1808, an escort of stilt-walkers, who went out to meet her, followed her carriage with ease though the horses were at a full trot. While the court remained there, the ladies had much sport in getting up stilt races, and in throwing

handfuls of money on the ground to be scrambled for by the stilt-walkers.

At Namur in Belgium contests on stilts take place between parties of several hundred on a side. Each company marches with its band to the public square, and at a given signal rushes upon the other, the side that gives way first being the loser. Bad tumbles and sometimes serious accidents result. Some of the natives of Oceanica, especially those of the Marquesas Islands, are very expert in the use of stilts.

STOCKING, a covering for the foot and leg, usually knit or woven. In old times stockings were made out of pieces of cloth, sewed together. They were afterward knit by hand with knitting-needles, and many are still made in this way in country places, but most stockings sold in stores are now made by machinery. There are many different kinds of knitting machines, some of which knit not only stockings, but other goods also, such as gloves, mitts, undershirts, drawers, scarfs, and comforters.

The word stocking is from stock, Anglo-Saxon *stocc*, a stock or trunk, and means a covering for the stock or stump, that is, the leg.

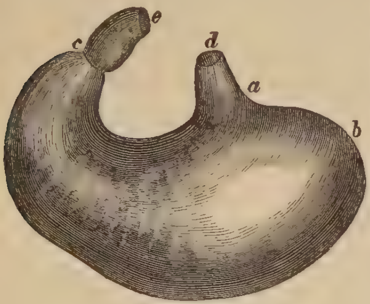
STOMACH. In the article BLOOD is told that the blood is all the time being renewed and made good by food. The food which we eat becomes blood, but as it is for the most part solid, it has to be changed much before its goodness can be taken out of it by the blood. This change, which is called digestion, is made in the stomach. The food which we take into our mouths is cut by the incisors or front teeth, and ground up by the molars or back teeth, and the finer this is done the better. While this is going on it becomes mixed with the saliva or spittle, which is mostly made up of water with a little ALBUMEN and SODA in it. This moistens the food and makes it smooth and slippery so that it may be the more easily swallowed. The saliva therefore is of great use and should never be wasted.

The tongue and the palate are fitted with many little nerves (see BRAIN) by means of which we are able to taste food. This taste, which we feel chiefly when chewing, may easily be spoiled by eating too much of rich and harmful food, or by chewing such things as gum, India-rubber, and tobacco; so that all who wish to enjoy their food should be careful what they put into their mouths.

After the food is chewed and softened it is swallowed, that is, it is passed down the gullet into the stomach. There is sometimes danger in swallowing. In the article MAN it is told that there are two pipes leading from the mouth down into the body, one of which is called the windpipe and the other the gullet. These pipes open close to each other, the windpipe in front and the gullet just behind it. The windpipe has a kind of lid at its mouth, which is usually closed when we swallow, so that the food slides over it into the gullet. When we talk, laugh, or make any other sound, this lid has to open to let the air pass, and if we do this at the same time that we try to swallow, some of the food will be sure to slip into the windpipe instead of going down the gullet. When food does this, or goes the wrong way, as it is usually called, it makes us cough and sputter until it is thrown out; but sometimes, when a hard or heavy substance gets into the windpipe, it sticks there and causes great pain, and it might cause death. Sometimes, too, food not chewed enough will stick in the gullet and cause much trouble, so that a surgeon has to be called in to get it out. So it is dangerous to talk or laugh when swallowing food, and it is also dangerous to swallow food that is not chewed enough.

From the gullet the food passes

into the stomach, where it is digested. The stomach lies about the middle of the abdomen, near the liver, and above the intestines or bowels. Its shape is something like the bag of a bagpipe, as will be seen in the picture. In this



Stomach of Man.

a, Neck; *b*, Great pouch; *c*, Pylorus; *d*, Gullet; *e*, Small intestine.

d shows the gullet, *a* the neck of the stomach, *b* the great pouch or principal end of the stomach, and *c* the pylorus or opening of the stomach into the small intestine, which is marked *e*. In the body the end marked *b* lies on the left side, and the intestine *e* bends over and then goes downward.

Digestion means the turning of the food which goes into the stomach into a kind of pulp suited for the use of the blood. As soon as the food enters, blood rushes toward the stomach and raises it to the right heat needed. When we have eaten a full meal we sometimes feel cool, because the blood, from which the heat of our bodies comes, has gone from the outside of the body to the parts around the stomach. This is generally a good sign, for we know then that the stomach is healthy and is doing its work; but if we feel flushed and warm after eating, it is good proof that something is wrong with the stomach. At the same time a kind of acid liquid called the gastric juice is poured out from the lining of the stomach into the food, which is also moved to and fro so that the gastric juice is mixed up with every part of it, until at last it is all churned up into a pulp. As digestion goes on, the pulp or chyme, which is a cream-like fluid, passes little by little through the pylorus, which means gateway, into the small intestine. After the stomach is emptied, the gastric juice stops flowing, the churning ceases, and all becomes quiet until more food is swallowed.

Only enough gastric juice flows to dissolve the food needed by the body, so that if more food than is needed be taken into the stomach some of it will be undigested, and will pass in that state into the intestines and cause pain. So we should always be careful not to eat too much.

The time needed for digestion differs according to the kind of food eaten, but it is generally from two to four hours. About 1822 a man named Alexis St. Martin, a boatman in the service of the United States, was badly wounded by the bursting of a gun, which tore away a good deal of flesh and a part of his stomach. He got well, but the hole in his stomach did not heal, and by pulling aside a piece of skin one could look into it and see its action. Dr. Beaumont tried a good many experiments with him, and by putting different kinds of food into his stomach through the hole, found out how long it took to digest each kind. The following are some of the foods tried and the time needed to digest them; beef, 2¾ to 3 hours; veal, 5 hours; mutton, 3 to 3¼ hours; lamb, 2½ hours; roasted pork, 5¼ hours; bacon, less than 3 hours; venison steak, 1½ hours; tripe, 1 hour; pig's feet, 1 hour; eggs, 3 to 4 hours; cheese, 3½ to 4 hours; bread, 3½ to 4 hours; rice, 1 hour; sago, 1¾ hours; potatoes, 2½ to 3½ hours; beets, 3¾ hours; and cabbage, 2½ to 4 hours. He also found out that uncooked vege-

tables, such as radish and lettuce, were much slower in digesting than cooked vegetables, like boiled potatoes and cabbage. Lobster alone by itself was very easily digested, but when mixed with lettuce and made into a salad it became much more indigestible.

The stomach is covered with a network of capillaries or little blood-vessels, which are all the time sucking up parts of the food as fast as it is digested. The rest of the chyme passes through the pylorus into the small intestine, where it is mixed with bile from the liver and another kind of juice, and divided into two parts. One of these, called the chyle, contains all the good parts of the food necessary for the support of the body, the other is almost all waste matter, which passes off through the bowels. The chyle is taken up by the blood in different ways and mixed with it.

The stomach does its work best when the mind is at ease and the body is rested. Children often rush to the table when heated and excited with play, but, though it may not seem to hurt them at the time, they will be pretty sure to suffer for it when they grow older. It is far better to give the body time to rest and become cool, and the nerves a chance to become quiet before eating: the food will not only taste better, but it will also digest better. Meals, too, should always be eaten at regular hours. Much harm is often done to the health by the habit of eating irregularly and between meals. The stomach needs rest as well as the other parts of the body, and if it is all the time worried with extra food it will soon become worn out and refuse to do its work. A large part of the ills of the body come from the abuse of the stomach. There ought to be about five hours between meals, and meals should be served at the same hours each day. Time, too, should always be taken for eating, for there is no worse habit for our health than that of swallowing our food in haste. The few minutes gained by hurrying in this way is sure to be dearly paid for by and by.

It is said above that when food is taken into the stomach the blood rushes toward it and raises its heat. This is because a certain amount of heat is needed to rightly digest food. On this account we ought to keep pretty quiet for a while after eating, for violent exercise always causes a rush of blood to the surface of the body; and as this draws the blood away from the stomach, it does not have heat enough to digest the food rightly. It is not necessary to remain perfectly still, for moderate exercise, which does not heat the blood, will harm no one; but such kind of play as running, leaping, and skipping the rope should not be indulged in for at least a half hour after eating. Brain work, too, causes the blood to rush toward the head, and children therefore should not study for at least an hour after a hearty meal.

The stomachs of most animals are like that of man, but those of ruminating MAMMALS and of BIRDS are different.

The word stomach is from the Latin *stomachus*, Greek *stomachos*, the stomach.

STORK, a bird of the heron family that lives chiefly in the warm parts of Europe, Asia, and Africa. It is a wading bird with very long legs, and loves damp marshy places, its food consisting of fish, reptiles, insects, and garbage. The common kind is mostly white, with black quills and wing coverts, and bill and feet red. It lives in Africa in winter, but crosses the Mediterranean in flocks in the spring, flying generally by night, and spends the summer in Europe. Storks are very plentiful in the warm season in Germany and Holland, where they build their nests and raise their young often in crowded cities. They occupy the same nests

year after year, the male birds repairing them each season. The stork has been considered from ancient times as the symbol of piety and filial love. In some places people used to worship it, and it was a crime to offer it any violence. Stories are told of storks that have sacrificed their own lives in trying to save their young when the building on top of which they had made their nest was destroyed by fire. In Germany storks are taught to perform in shows like trained dogs and other educated animals. They jump through hoops, mount ladders, walk the tight-rope, pretend to fall dead when a pistol is fired, and do other tricks.

The stork belongs to the order *grallatores* or wading BIRDS.

The word stork is in Anglo-Saxon *storc.*

STOVE. The Romans had stoves for heating their baths, but they were not like those used now. They were square boxes made of brick, tiles, soapstone, or slate, and sometimes so large that they nearly filled one side of a room. This kind of stove was used generally in Europe until iron stoves began to be made, and in some of the northern countries the broad flat top was the the sleeping-place of the family. In Sweden and Germany stoves made of tiles and plates of porcelain are still in use, and some of them are made very handsome with paintings and ornaments.

Iron stoves were made in France and in Holland early in the last century, but none of them were good for much. In 1745 Dr. Franklin first made his stove, which for a long time was the best one in use. It was like the open iron fireplaces often seen in old houses, but was fitted with a kind of sliding iron door, by which the front might be closed up to make the draught stronger. As soon as the fire was going well the door could be slid back, and the stove made into an open fireplace.

Many kinds of stoves are now made in the United States: some of cast-IRON and some of sheet-iron; some for burning wood and some for coal; some for warming rooms and some for cooking. Some stoves, too, are made out of soapstone, and some are made for burning gas or petroleum for fuel, instead of wood or coal. A range is a cooking stove built into the chimney of a house, so that it cannot be moved like a common stove. It has holes for pots and kettles on top, like other stoves, and has ovens either at the sides or above the top. A furnace is a large stove, built usually in the cellar of a building, and fitted with a chamber where air is heated, and from which it is carried in large tin pipes through the walls to heat rooms above. In this way a single large fire is made to heat a whole house. Many buildings are now heated by steam made in a boiler in the cellar and carried in small iron pipes into rooms, where it fills a coil of pipes called a heater, usually set against the wall. This warms the air of the rooms and gives a very pleasant heat.

The word stove is from the Anglo-Saxon *stofa*, a bath room, meaning a heated room.

STRAW, the stem of wheat, rye, and others of the cereal or grain grasses. Straw has many uses on the farm and in the house; and in the arts it is made into PAPER and plaited into hats and bonnets. The best straw for hats is that of a kind of wheat which grows in Italy, where it is largely woven into braids and sent in that state to foreign countries. The wheat is cut before it is quite ripe, dried in the sun, and afterward bleached in the sun and dew, and by steaming it with sulphur. It is then separated into different sizes, and woven into long braids, like tape, by women and girls, ready to be sewn together to make straw hats and bonnets. When finished the braids are flattened by pressure, and then

put up in rolls for sale. The braids are of many different patterns, and of many qualities from very coarse to very fine. Some hats, such as Leghorn hats for women and children, are brought to the United States from Italy already sewn together, and are pressed out and finished here.

What are called chip hats are not made, as many think, out of straw, but out of splints of the Lombardy poplar. Logs of this wood are buried in the ground for three years to dry out the sap, which, if dried in the air, will turn red. When cured, the logs are split up into fine splints, and woven into braids in the same way as straw. In Switzerland an imitation of chip braid is made by machines out of tape. A great many straw braids also are made in Switzerland and sent to this country.

Large quantities of straw braid and hats are brought here from China. The hats are mostly what are called grass hats, being made out of a coarse kind of grass. The hats called Panama hats are brought from South and Central America. They are made from the leaves of a kind of screw palm that grows only on the slopes of the Andes. The leaves are cut into shreds like straws, bleached, and woven into hats around a block of wood. Large numbers of Indians are employed in this work.

The straw braid brought to this country is made into hats and bonnets by the straw-sewing machine, which will sew a hundred a day. The hats are then pressed by another machine, which smooths them ready for trimming at the rate of four a minute.

The word straw is from the Anglo-Saxon *streow*, meaning litter or what is strewn to lie on.

STRAWBERRY. The strawberry PLANT grows wild in all the temperate parts of Europe and Asia, all over the United States from the Atlantic seaboard to California, in Canada, Mexico, and in Chili and other parts of South America. The Greeks and Romans knew it but did not cultivate it. It was not cultivated in Europe until about the fifteenth century. The plant has long runners, with a bud at the end which forms roots and leaves, and finally a new plant, when the stem joining it to the old plant decays. The flowers are usually white, and what is commonly called the fruit is only the enlarged receptacle, or end of the flower stalk, the true FRUIT being the little seeds on the outside of the berry. The berries are usually bright red, but sometimes white. The wild strawberry is found nearly all over the United States, and in most other mild climates. The cultivated kinds were got by planting the seeds of the wild strawberry. Northern markets are supplied with berries in the early part of the season from Georgia and South Carolina, then from the more northerly Southern States, next from New Jersey, and lastly from New England.

The word strawberry is from the Anglo-Saxon *streawberie*, strawberry. The plant is so called, perhaps, from its straw-like stems; but some think it should be stray-berry, from the straying of its vine.

STRONTIUM, a metal, one of the ELEMENTS. It is pale yellow when pure, is about as hard as gold, and may be hammered into very thin plates. It is found mixed with carbon in a carbonate called strontianite, first found in 1787 in Strontian, Argyleshire, Scotland, from which it gets its name. Sir Humphry Davy separated the pure metal in 1808. It is found also in different forms in Sicily, Switzerland, Austria, and Canada, and in the United States in New York and Pennsylvania. The nitrate of strontium, which burns with a splendid crimson light, is largely used in making the crimson lights of fireworks.

STURGEON, a large fish with a long spindle-shaped body covered with a rough skin, and with a flat-

tened head ending in a three-cornered snout, covered with bony plates. It is found in the seas and rivers of Eastern Europe, Western Asia, and Northern America. The sturgeon of the Caspian and Black seas is often ten feet long. Its flesh is much eaten, both fresh and salted. The roes, washed with vinegar, salted, dried, and pressed into cakes or packed into casks, is the caviare of commerce. That made from the roes of the sterlet, a smaller kind of sturgeon, is the best. ISINGLASS is made from the air bladders of the sturgeon, and leather from the skin. There are several kinds of sturgeon in the United States, the most common of which are the sharp-nosed, found along the coasts of New England and Long Island, and the short-nosed, which is caught in the Hudson river. The flesh of both is much esteemed for food.

The word sturgeon is from the Anglo-Saxon *styria*, Latin *sturio*, sturgeon.

SUCKER, a fish of the same family with the CARP, of which many kinds are found in the rivers and lakes of the United States. The common sucker of the New England and Middle States is from eight inches to more than a foot long, brownish on the back, reddish-brown on the sides, and white below. It has no teeth, and its lips are made for sucking. This fish is hard to catch, because it will seldom suck in a bait. There is a large kind, called the buffalo sucker, found in the Mississippi and other Western rivers, which is sometimes more than a yard long.

The sucker is so called because it sucks in its food.

SUGAR. Most of the sugar used in the world is made from the juice of the sugar cane. Sugar cane first grew in Southern Asia, whence it spread into Africa; it was carried into Spain by the Arabs, and the Spaniards took it with them to the West Indies, whence it was brought to Louisiana about 1751. It is now raised in several of the Southern States. In very hot countries a sugar cane plantation will last sometimes for ten years, but in this country, where it is cooler, the cane must be planted every two or three years. It is never raised from the seed, but pieces of the cane are cut and planted, and new canes sprout from each joint.

Sugar cane is a kind of grass, which looks much like Indian corn. It has a hard and solid stem that grows in joints, and which is sometimes three times as high as a man, but commonly only once or twice as high. The leaves are long, ribbon shaped, and pointed, and hang over like Indian corn leaves. There are many kinds of sugar cane, the stalks of which are of different colors, some being green, some yellow, some purple, and some purple and yellow striped.

As soon as the canes are ripe, which is usually in August, they are cut and taken to the mill to be ground. Every large sugar plantation has its own mill, generally driven by steam, where the canes are crushed by passing them between large iron rollers, which squeeze out all their juice. A little lime is put into the juice at once and it is heated for a short time, because if left to itself it would begin to ferment (see BEER) or work in less than an hour. The lime prevents this and brings to the top of the liquid as a scum any impurities in it. This is skimmed off, and the clear liquid is gradually boiled down in large copper pans until it is so thick that it will crystallize, or turn into sugar crystals, when it cools. It is then poured into great wooden coolers with thick sides and about a foot deep, in which it cools very slowly. In about a day the sugar forms in a soft mass in the middle, all the rest being molasses. The whole is now put into hogsheads with holes in their bottoms, which are set upon frames

over a large vat, and into this the molasses is allowed to drip for five or six weeks, when the sugar is dry enough to be shipped.

The sugar thus made is the common brown sugar, sometimes called raw or muscovado sugar, from a Spanish word meaning unrefined, and is usually refined before it is used. This is now done sometimes at the plantations, but it is generally done in the northern United States or in England. The sugar is first melted in hot water, which is then pumped up to the top floor of a high building into pans heated with steam. Lime is put into the syrup and it is let run down to the next floor through bags made of cloth, which strain it. The syrup, which looks like sherry wine as it comes out of the bags, now runs into great hollow cylinders filled with BONE black or animal charcoal, which takes out all of the color. It is boiled again in vacuum pans—that is, covered pans from which the air is all pumped out with the AIR PUMP. This soon takes out all the dampness and the sugar crystallizes again, and this time perfectly white. When drained in moulds it becomes loaf sugar; but when the syrup is separated or driven off by a machine which whirls it rapidly around it is called granulated sugar. The syrup is sold under various names, such as sugar-house syrup, golden drips, etc., and is used for eating on breakfast cakes and for cooking purposes. The loaf sugar is sometimes sold in loaves, and sometimes cut up into square lumps, crushed into small pieces, or ground to a powder.

Beet sugar is made in nearly the same way as cane sugar. MAPLE sugar is made in the northern United States by boiling down the sap of the sugar maple. Both of these, when refined, are the same as cane sugar, but maple sugar is usually eaten in the crude state, as most people like the taste of it. Beet sugar is not fit to eat until refined.

Sugar is made up of CARBON, HYDROGEN, and OXYGEN. There are different kinds of sugar, but they are all made of the same things, only the quantities are not the same. Cane sugar, the most important of all, has less hydrogen and oxygen in it than grape sugar. Grape sugar, which is sometimes called dextrose or glucose, and sometimes starch sugar, is the kind which is in grapes and in many other sweet fruits. It is easily made out of starch, which is composed of just the same materials as sugar; the only difference is, it does not contain so much oxygen and hydrogen. If now we can add enough of these two things to the starch to make them equal to the amount in sugar, leaving the carbon just as it is, the starch will turn into sugar. This is done by boiling the starch in sulphuric acid and water; the acid forces some of the OXYGEN and hydrogen of the WATER to unite with the carbon, and makes sugar, or rather a syrup in which sugar is mixed with the sulphuric acid. The acid must now be taken out. This is done by putting some chalk in. Chalk is carbonate of lime, which is made up of carbonic acid and lime. When it is put into the mixture the sulphuric acid at once combines with the lime and frees the carbonic acid, which passes off into the air as a gas, and the sulphuric acid and the lime make sulphate of lime or gypsum. As this will not dissolve in water, the syrup can be easily freed from it, and then boiled down until most of the water is driven off as steam, when the sugar will crystallize.

Grape sugar can be made out of sawdust, or out of cotton or linen rags just as easily as out of starch, for they are formed of the same materials, carbon, oxygen, and hydrogen. We have only to alter the proportions to change them into sugar.

Grape sugar is not so sweet as cane sugar, and is therefore not so

valuable; but it is often mixed with it, especially in making CANDY. It is used in the manufacture of ALCOHOL, and in the sweetening of certain kinds of wine and beer.

The word sugar is from the Hindoo *shukar*, Persian *shakur*, Arabic *sukkur*, which are from the Sanscrit *sarkara*, sugar.

SULPHUR, one of the principal non-metallic ELEMENTS. At common heat it is a light yellow, brittle solid, without taste or smell. It is sometimes found by itself, but usually united with some other of the elements. Many ores of metals are made up of metals united with sulphur. Such ores are called sulphides; for example, the ore of lead called galena is properly sulphide of lead, and the ore of iron called iron pyrites is sulphide of iron. Free or unmixed sulphur is brought mostly from volcanic countries; a large part of that used in commerce comes from Sicily. It is usually in dirty yellow lumps, and has to be purified. This is done either by melting it in pots and drawing off the liquid sulphur, or by heating it in close iron vessels called retorts, until it boils, and collecting the vapor which rises from it in a large cool chamber, on the sides of which it forms again in a yellow powder called flowers of sulphur. Sometimes the vapor is collected in a liquid form in a small hot chamber, drawn off and cast into small rolls called roll brimstone. Sulphur is much used in the arts, especially for making GUNPOWDER and MATCHES, for vulcanizing INDIA-RUBBER, for bleaching, and for making SULPHURIC ACID.

The word sulphur is Latin. Brimstone is from the Old English *brynston*, burnstone, which is from the Anglo-Saxon *brinnan*, to burn, and *stan*, stone.

SULPHURIC ACID is made up of SULPHUR, HYDROGEN, and OXYGEN. It is a thick, oily, colorless, and very biting liquid, and quickly chars and destroys most animal and vegetable substances. It is commonly called oil of vitriol, because it was first made from green VITRIOL (sulphate of iron) and because it pours like oil, but it is now usually made by adding more oxygen to sulphurous acid. Sulphuric acid is one of the most important compounds in the world. It is largely used in the making of most of the other acids, as well as of SODA, PHOSPHORUS, and ALUM, in bleaching, dyeing, and calico printing, in the refining of PETROLEUM, in the making of fertilizers or manures for enriching land, and in many other ways. Sulphuric acid unites with metals to form important compounds called sulphates; thus we have ALUMINUM sulphate or alum, SODIUM sulphate or Glauber salts, MAGNESIUM sulphate or Epsom salts, CALCIUM sulphate or GYPSUM, iron sulphate or green vitriol, copper sulphate or blue vitriol, zinc sulphate or white vitriol, etc.

The name sulphuric acid is made up of the words SULPHUR and ACID.

SUMACH, the common name of several kinds of shrubs or trees growing nearly all over the world, and which are much used in tanning, dyeing, medicine, etc. The common sumach of the United States is the smooth sumach, a shrub which grows ten to twelve feet high, with greenish-yellow flowers and sour crimson fruit, growing in clusters. The leaves are often bright scarlet and yellow in the autumn.

The **Venetian Sumach** of Southern Europe is the common smoke tree or fringe tree of the gardens. In Italy it is used in tanning; the leaves are used in dyeing Turkey red, and the root also is valuable for dyeing.

Poison Sumach, called also swamp sumach because it grows in swamps, and poison dogwood and poison elder, is a beautiful shrub from six to fifteen feet high. It bears small greenish-yellow flowers and in June

and July nearly round greenish-white berries hanging in clusters on stems

Poison Sumach (in fruit). Figure one-quarter natural size. Below, fruit of the natural size.

six to eight inches long. It has a milky juice, which dries like a black varnish. The Japanese make their LACQUER varnish from a poison sumach very much like this.

Poison Ivy, or poison oak, sometimes called mercury vine, is also a kind of sumach. It grows in two forms, one a low shrub seldom more than three feet high, except in California, where it becomes quite a large tree, and the other a vine which clambers over walls, rocks, and trees, sometimes to a great height. In both forms the leaves grow in threes, as in the picture, and the fruit is greenish-white berries. It is very poisonous, though not quite so much so as poison sumach, and often poisons people who only pass near it without touching it.

The **Sumach of Trade** is the crushed or ground leaves of a small kind of sumach grown in Spain and Italy, especially in Sicily. It is valuable for tanning light-colored leather and for dyeing cotton cloths of a bright yellow. The leaves of the smooth sumach and of some other kinds are used in this country for the same purposes.

The word sumach is from the Arabic *summaq*, sumach.

SUN. The sun is so bright that it dazzles the eyes to look at it, and it therefore looks like a mass of light with rays darting from it on all sides; but if it be looked at through a smoked glass it will be seen to be a bright ball. Unlike the moon, it never changes its form, but is always round. This is because its light comes from itself. In the article UNIVERSE it is told that the sun is the centre of a group of bodies called planets, including the earth, which are all the time rolling round it in great circles called orbits. It is also told that all the planets and their moons are cool bodies, and therefore give out no light and heat, but get all their light and heat from the sun. Now we know that the

Poison Ivy (Poison Oak) in flower. Branch one-quarter natural size. Below, berry of the natural size.

distance of the sun from us is so great (92,000,000 miles) that our minds can scarcely think of it. The sun therefore must be very large and very hot. It does not look much larger than the full moon, but it is really many million times larger. It would take forty-nine of our moons to make a globe of the size of the earth, and it would take more than one and a quarter million (1,280,000) globes as large as the earth to make one of the size of the sun. It looks small to us because it is so far away.

Our mind cannot form any just idea of the great heat of the sun any more than it can of its distance from us. We can only think of it as an immense globe of fiercely burning fire, but we know of no heat on earth to compare it to. It is so hot that nothing on its surface is solid or even liquid; everything is in the shape of a white-hot gas (see ELEMENT). Most astronomers think that it has no solid part, but that it is mainly a ball of burning gas, which is denser, or more closely packed together, in the middle, on account of the weight of the gas on the outside, but which is kept from turning into a liquid by the great heat.

We cannot see much of the sun unless we look at it through a TELESCOPE. We have to be very careful in doing this, and use darkened glasses, for its great brightness would be very apt to blind us even if we used only a small telescope. Through a piece of common smoked glass the sun looks bright all over its surface, but through a telescope black spots are often seen on it. Some of these spots look like great hollows large enough to put several earths in; but though they are hollows, they are really not empty but are filled with gases. These gases stop the light from below and thus make them look like black spots. Around their edges great banks of burning gas glow like blazing furnaces, and both spots and banks of flame are all the time changing their shape. But the round sun which we commonly see is not all there is of it. This is only its denser part, and hundreds of thousands of miles above it reaches a mass of burning gases, making an envelope around the sun just as the AIR does around the earth. We cannot see this envelope any more than we can see the stars in the daytime, on account of the great light of the body of the sun; but when in an eclipse the light of the sun is cut off by the moon so that it does not dazzle our eyes, the burning gases can be seen shooting out from the surface of the sun hundreds of thousands of miles. They appear of many beautiful colors, red being most common; and of many shapes which often change. By using an instrument called the spectroscope (Latin *spectrum*, the image of LIGHT passed through a prism, and Greek *skopein*, to view), by means of which light is separated into the colors of which it is made, we can tell what the sun is made of. By examining the sun's light with this it has been found that many of the ELEMENTS which are on the earth are also in the sun, but not in the same form, of course, because the heat in the sun is so great that metals are turned into vapor just as water turns into steam here. Among the elements found there are HYDROGEN, OXYGEN, SODIUM, BARIUM, CALCIUM, MAGNESIUM, ALUMINUM, IRON, COBALT, NICKEL, ZINC, COPPER, and others.

Like the planets, the sun is all the time spinning like a top. It turns round once in about twenty-five days and eight hours, moving always from east to west.

The word sun is from the Anglo-Saxon *sunna*, sun.

SUNFISH, the name of a common fresh-water fish, found in all streams from Maine to Georgia and in the Great Lake region, but not in the Mississippi Valley excepting in the northern part. It gets its name probably

from its round shape. In the Lake region it is sometimes a pound and a half in weight, but is generally smaller. The sunfish has many local names, such as pumpkin-seed, bream, pond-perch, coppernose, sun-perch, and sunny. In the spring the female builds a nest by clearing a space about a foot wide near the bank of all plants and then scooping a hole three or four inches deep in the clean gravel or sand, in which she deposits her eggs. She then watches it with the greatest care, driving away all other fish, until the young ones are hatched.

SUNFLOWER. Almost all the kinds of sunflower grew first in North America. The name was given to it on account of its resemblance to old pictures of the sun with flaming rays around it, and not, as some say, because it always turns its face to the sun. It is often seen in old-fashioned country gardens, but it so soon exhausts the soil that it is not a profitable plant to raise. The seeds are sometimes fed to poultry and it is given to horses as a remedy for heaves. The Indians of the West gather for food the seeds of the wild sunflower, which they parch and carry on their hunting excursions; they also grind them into meal and make thin cakes which they bake in the ashes, and they are said to be as good as corncakes. The stem of the wild sunflower yields also a creamy white gum which is chewed by Indian and white children in Utah.

SWALLOW. Swallows have large wings, a forked tail, and short legs. They are very swift flyers and live more of the time on the wing than any other birds, spending most of the day wheeling in circles through the air, sometimes soaring very high, and uttering shrill screams. Their food is chiefly insects, which they catch in the air while flying, their mouth being very large and wide, and they even drink on the wing, scooping the water up from the surface of ponds and streams. They build their nests of mud, mixed with straws, hairs, and soft threads, which they plaster on to some building, usually under the eaves. They lay five or six eggs, and raise two broods each season.

The **Barn Swallow** is the best known swallow in the United States. It spends its winter in the Southern States, coming north in May and going southward again at the end of August. It is much like the chimney swallow of Great Britain in its habits, building its nest usually against the rafters of barns and sheds or inside of old chimneys.

The **Chimney Swallow** of the United States is properly a swift and not a swallow. It also comes from the South in the spring and returns thither about the first of September. It builds its nest in hollow trees or unused chimneys, of dry twigs which it breaks off from trees as it flies, and glues together with a sticky liquid from its own mouth. Chimney swallows or swifts live in flocks. It is amusing to see a large flock of them going down an old chimney where their nests are: they wheel round and round in circles and each time they pass over the chimney the lower ones drop in until all are safely in. They make a loud whirring noise in passing in and out of a chimney.

A kind of swift or swallow in China makes the edible birds' nests so much valued by the Chinese for food. The nests are a glue-like substance which the birds get from their own mouths and which they mix usually with grass and hairs. It melts easily in water, and makes excellent soups and gravies.

The swallow belongs to the order *insessores*, or perching BIRDS.

The word swallow is from the Anglo-Saxon *swalewe*, swallow.

SWAN. The swan is one of the largest and most beautiful of water birds, and has been admired in all times for the elegance of its form and the grace of its movements. It

is found in almost all parts of the world, living when wild on lakes, rivers, and sea-coasts, especially of cool countries. Swans, when full grown, are usually pure white and have a red bill; but the young, which are called cygnets, are bluish-gray with a lead-colored bill. They are clean birds and take great care of their feathers. Their food is chiefly the roots and seeds of water plants, but they also eat worms, young frogs, and small fish. They build their nests of grass and reeds, near the water, and lay six to eight greenish-white eggs and sit about six weeks. The male bird guards the nest while the female is sitting, and savagely fights anything that comes near it.

Swans show great courage also in defending their young, and one has been known to drive off even an eagle which had attacked her brood. They fight usually with their wings, with which they can strike very heavy blows. A female swan who was on the bank of a river with her brood of young once saw a fox swimming across toward her. She did not wait for the enemy to come on shore, but took to the water and swam out to meet him, and attacked him with her wings with such fury that the fox was drowned.

The **Black Swan,** found in Australia, is much like the white swan in form, but is all black excepting a few small feathers which are white, and has a red bill. These birds live when wild in flocks of eight or ten. Many have been tamed and they are now to be seen in public parks.

The **Tame Swans** kept in parks and public gardens are descended from the wild swan, but differ from it a little. The young are always white instead of bluish-gray. The finest tame swans are those called Polish swans, which are brought chiefly from Germany, where many are raised. They are now to be seen in almost all our public parks that have ponds in them. Great numbers are kept on the river Thames, in England, many of which belong to the Queen, and others to companies in London which keep them. The cygnets are caught and marked every year with the mark of the company to which they belong.

In old times in England the flesh of the swan was served on the tables of nobles, but this was more on account of the scarcity of the bird than because its flesh was good. It is sometimes eaten now, but its meat is dry and has little flavor.

The ancients called the swan the bird of gods and goddesses, and its beauty was described by many poets. Its voice was called sweet and musical, though to our ears it is a harsh trumpet-like cry, and it was said that in dying it always sang a mournful song. From this ancient story, which is not true, have been made many poems and songs.

The swan belongs to the order *natatores*, or swimming BIRDS, and to the duck family.

The word swan is Anglo-Saxon.

SWEET-FLAG, a kind of reed which grows in swamps and ponds, and along the banks of rivers. It is found in the cooler parts of North America and Europe, and in some parts of Asia. Its roots, which have a strong smell and a biting taste, are used by confectioners in making some kinds of candy, by perfumers in making toilet vinegar, and sometimes by physicans. It is also chewed sometimes. The leaves have a sweet smell when bruised, and in old times were used like rushes to strew on the floors of houses and churches.

The name sweet-flag is made up of the Anglo-Saxon *swet*, sweet, and the Danish *flæg*, a marsh plant.

SWEET POTATO. When Columbus went back to Spain after his discovery of the New World he carried with him, among other presents for Queen Isabella, some sweet potatoes. Some think these were

the first sweet potatoes ever seen out of America, but others think that this vegetable was grown in China and in India long before this country was known. Wherever it first grew, it became well known in Europe before the white potato, and not long after Columbus took it to Spain its tubers or roots were carried to England and sold there as a great delicacy; and it is the sweet potato which Shakespeare and other early English writers mean when they speak of potatoes.

The sweet potato is a creeping vine, with leaves commonly heart-shaped, and large purple flowers with white on the edges, much like the morning-glory in form. The tubers, which grow somewhat like those of the white potato, are really underground branches, and not roots.

They differ much in size, some being nearly round and some long and pointed; and also in color, some being yellow, some red, and some nearly purple. The sweet potato is largely cultivated in hot countries, and gives food to a great many people. It is common in all the southern United States, and is grown as far north as New Jersey and Ohio.

Sweet potatoes are sometimes grown in the South by planting pieces of the roots, but in the North from slips or cuttings. In places where there is no frost, the vine takes root at the joints and grows all the year round without replanting; but in cold places the potatoes are planted in warm beds until they sprout, and when the sprouts root they are broken off and planted. Sweet potatoes raised in the North are more mealy than those grown in the South, because they have more STARCH in them; those from the South are damper and sweeter because they have more sugar in them.

The sweet potato was first called potato by the early English writers; the word potato is from the Spanish *batata*, which is probably from some Indian word, and which was first given to the sweet potato and afterward to the white potato.

SWORD-FISH, the common name of a large fish, related to the mackerel; so called because its upper jaw is lengthened out into a long weapon like a sword, which it uses to stab its prey with. The sword-fish is usually ten to twenty feet long, bluish-black on the back, and white below, and the sword is about one-third the length of its body. It feeds on fish, chiefly mackerel, and may often be seen following their shoals along the coast of New England. It is caught with the HARPOON, and its flesh is eaten, although it is rather coarse.

The sword-fish can go though the water very fast, and as it is sometimes quite heavy, its blade is thrust into its enemies with great strength. It often fights the whale, which is too clumsy to ward off its attacks, and kills it by stabbing it from below. Sometimes it runs its sword through the bottom of a ship, mistaking it, perhaps, for a whale. A ship sailing along quietly has all at once felt a shock as if a rock had been touched, and after getting into port the broken blade of one of these fish has been found sticking in its side. Persons bathing, too, have sometimes been stabbed by sword-fish.

The name sword-fish is made up of the Anglo-Saxon *swurd*, sword, and *fisc*, fish.

SYCAMORE. See PLANE TREE.

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TAMARIND, the fruit of a large tree that grows wild in various parts of Africa and Asia, but which is now cultivated in the West Indies and in South America. The fruit is a pod, five or six inches long and as thick as a man's finger, containing a row of seeds, which are surrounded by a sour, juicy pulp. When the pods are ripe they are picked and the fruit shelled out, packed into casks, and covered with boiling syrup. The West India tamarinds are preserved in this way, but those from the East Indies are put up without syrup. In warm countries a cooling acid drink is made from tamarinds. It makes a pleasant drink for those sick with fevers. The wood of the tree is used for cabinet work, but is so hard that it is wrought with difficulty.

The word tamarind means Indian date, being made up of the Arabic words *tamr*, a dried date, and *hindi*, Indian.

TAMBOURINE, a musical instrument of the drum kind, made of a thin hoop of wood or metal, covered with tightly-stretched parchment, and hung with little bells. It is held in one hand and played by striking it with the knuckles of the other, and sometimes with the elbow. The tambourine is a very ancient instrument, and has always been much liked by peasant and gypsy dancers. It is sometimes used in orchestras, and always in negro minstrel troupes.

The word tambourine is from the French *tambourin*, diminutive of *tambour*, a drum.

TANAGER. The tanagers, of which there are many kinds, are found only in America, and chiefly in the warm parts. One of the most beautiful of them, the scarlet tanager, comes from Mexico in April, is found in New York State about the middle of May, and afterward in New England and Canada. The male is bright scarlet, with wings and tail glossy black, and the female yellowish green. It is a shy bird and lives mostly in woods, seldom coming near houses. It does not sing much, but has a lively chirp, somewhat like "chip, churr." Its nest is built in trees and bushes, and it lays four or five greenish-blue eggs, specked with purple and brown. The scarlet tanager does not like cold weather, and goes southward early in September, flying usually by night. It is a very beautiful pet, but hard to tame.

The **Summer Red Bird,** another tanager, is found mostly in the Southern States, but is sometimes seen in the Middle States and southern New England in warm weather. The male is light red, with dusky-brown on the back and on the ends of the wing and tail feathers, and the females are olive above and reddish yellow below. It lays four or five light blue eggs.

The tanager belongs to the order *insessores*, or perching BIRDS, and to the finch family, in which are also the larks and sparrows.

The word tanager is probably from *tangara*, the Brazilian name of these birds.

TAPIOCA, a starch-like substance obtained from the root of the mandioc or CASSAVA plant. The root is grated and thoroughly washed in water, and afterward dried by heat and made into grains. Where tapi-

oca is largely made this is done by machinery. The roots are placed in revolving cylinders, where they are cleansed and finally rasped to a pulp which flows into open vessels, where it is allowed to settle. The water is then drained off, and the starchy sediment is washed and dried over a fire, when it is packed for sale. Much tapioca is made in Singapore and Penang in the Straits Settlements. Tapioca is an important food in South America. In the United States it is much used in soups and for making puddings and blanc mange.

The word tapioca is from the Brazilian *tipioca*, the juice of the cassava root.

TAPIR, a thick-skinned, hoofed animal, found in South America and Asia. It looks somewhat like a hog, but the legs are longer, and it has a long flexible snout which it uses to grasp things with. The skin is covered with close short hair, and the neck has a short stiff mane. Tapirs live in moist tropical forests, and usually sleep by day in retired places, coming out by night to feed on fruits, grasses, and other vegetable substances. They are fond of rolling in the mud and are good swimmers, generally taking to the water when pursued. Their flesh is eaten both in South America and in Asia. The South American tapir, which is about 6 feet long and 3 feet high, is of a uniform brown color. It is found almost all over South America east of the Andes. The Asiatic tapir, found chiefly in the Malay peninsula, is 7 or 8 feet long, with the hinder parts white and the fore parts and legs black.

The tapir is a MAMMAL of the order *pachydermata*, or thick-skinned animals.

The word tapir is from the Brazilian *tapyra*, tapir.

TAR, a black, impure kind of TURPENTINE, made by burning the wood of pine and fir trees. Much tar is made in the United States, especially in North Carolina and Georgia, from the same kind of pine trees from which turpentine is got. Trees which are too old to yield turpentine and dead trees are usually picked out for making tar. A shallow hole is dug in the top of a bank, and the bottom and sides rammed down hard. A large cast-IRON pan is put into the bottom of the hole, having a spout which sticks out through the side of the bank. The hole is then filled full of pieces of pine wood, packed closely so as to fill the whole space, and covered over with turf and earth, a place being left to set fire to the heap. As the wood burns slowly, the tar melts out of the wood, runs down into the iron pan, and thence off through the spout into barrels, which are bunged and sent off as fast as filled. Tar is soft when warm and runs like molasses, but becomes thick and hard in cold weather. Its black color comes mostly from the smoke in burning. After all the tar has run out of the burnt wood nothing but charcoal is left. Wood tar is much used for tarring the ropes of ships to preserve them from the water, and also for covering wood. Tarpaulins are sheets of coarse canvas painted with tar, used for covering goods to keep them dry. When tar is boiled in an open iron pot until most of the watery matter passes off in steam, it becomes a solid and shiny substance called pitch, which is brittle when cold, but becomes soft when heated. Pitch is much used in ship-building, for covering the bottoms of vessels, caulking seams, etc. For coal tar see GAS.

The word tar is from the Anglo-Saxon *teoru* or *teru*, tar.

TARANTULA, a large spider of southern Europe. It is sometimes two inches long in the body, and is ashy-brown above and saffron-colored below. It makes no web, but lives in holes in the ground and in crevices, which it lines with a substance like silk. It comes out to seek its prey,

running it down with great swiftness. The bite of the tarantula, which is painful but not deadly, was once thought to produce a disease called tarantism, believed to be curable only by dancing to lively music. The tarantilla, a whirling dance for a single couple, common in Italy in the sixteenth century, was thought to be good for it, and gave rise to the music of the same name.

Several kinds of large spiders in the warmer parts of America are called tarantulas. They are sometimes brought from the West Indies among bunches of bananas. Their bite is poisonous, but is not necessarily deadly, as some think.

The tarantula belongs to the second class of articulate ANIMALS.

The tarantula gets its name from Taranto (Tarentum), Italy, near which it is abundant.

TARPON, a salt water fish found in the western Atlantic and the Gulf of Mexico. It is sometimes caught as far north as New Jersey, but is plentiful on the Florida coast and among the West Indies. It grows to be very large, sometimes six feet long; and one has been caught that weighed 150 pounds. Its body is covered with white silvery scales, often two and a half inches wide, which are used for decoration, but its back is darker. Though it is edible, its flesh is coarse and not much prized as food. The tarpon is famous as a game fish, owing to its great strength and endurance, and the difficulty of taking it with hook and line; and it takes a very skilful sportsman to capture one. It is sometimes called also "silver-fish" and "silver-king," and by the French creoles "grand-écaille" (great-scale). On the coast of Texas it is called the "savanilla."

TAUTOG. See BLACKFISH.

TEA, the dried leaves of a plant that grows chiefly in China, Japan, and India. There are many kinds of tea, but they are all supposed to come from one kind of plant, the difference being made by the different soils and climates in which the plants grow, by the time of picking the leaves, and by the various ways in which the leaves are cured. The tea plant is an evergreen shrub which when wild grows four or five times as high as a man (25 to 30 feet), but which when cultivated is kept pruned so that it is usually a little less than a man's height. It is raised from the seed, and the plants

The Tea Plant.

begin to yield when three years old; they give the most leaves when eight or ten years old, and after that give less and less, and new plants are set out in their place.

In China tea plants are usually cultivated in small plantations, and the leaves are picked by the family. The first picking takes place in April, and is made up of buds and very young leaves. The shrubs soon put out more leaves, and a second picking is made in May. This is usually the most important crop. A third crop is picked about the middle of June, and a fourth in August. The leaves of the last picking are large and coarse, and make the poorest tea. In the picking season Chinese family groups may be seen on all the hillsides gathering the leaves. Each picker has a small bamboo basket slung by a cord around the neck, so

as to leave both hands free. The leaves are gathered very fast, and the baskets when filled are emptied into larger ones, which are carried to the curing places.

Teas are of two kinds, green and black teas, which are made from the same leaves, but are cured differently. When the leaves are dried quickly they make green tea, but when they are allowed to dry slowly, so that they ferment or work a little, they turn black and make black tea. The leaves are first slightly dried in shallow baskets in the sun, and are then put, a few at a time, in an iron or copper pan, heated usually over a charcoal fire, and stirred until they are dry enough, when they are emptied upon a table, where other workmen roll them with their hands into the little rolls in which we see them. They are afterward dried again, sorted, and made ready for packing. Black teas are often colored green with Prussian blue, TURMERIC, and other things. The Chinese do not dye the teas they use themselves, but only those they send to foreign countries. Teas are packed in chests lined with thin sheet LEAD, and with a thin, silky, straw-colored paper made from the bark of the paper MULBERRY. When the tea is poured into the boxes, a man gets in and stamps it down with his feet until the chest is filled tight, when the lead is soldered over it and the wooden cover nailed on.

In China and Japan tea is the common drink of the people, and there are public houses where it is sold in all the towns and along all the roads. It is always drunk clear, and never with milk and sugar, as we drink it. Rich Chinese make their tea in the cup, by putting in some of the leaves and pouring boiling water over them, but the poorer classes use a teapot. In Japan the leaves are sometimes ground to powder, so that they may be drunk with the tea. The Russians use lemon juice instead of milk and sugar.

The Japanese have a legend to explain the origin of tea. They say that a priest, who went from India to China about the beginning of the sixth century, fell asleep one day when he wished to watch and pray, and in a moment of anger cut off his eyelids and threw them on the ground, where they grew into the tea shrub, the leaves of which are good to prevent sleep. But the Chinese never heard of this story, and, as they cultivated tea more than two thousand years before Christ, it is more likely that it was carried from China to India than from India to China.

Tea was first made known in Europe by the Portuguese in the first half of the sixteenth century, but the habit of tea-drinking was introduced by the Dutch early in the seventeenth century. The English began to drink it about 1650. As first its price was very high, $30 to $50 a pound, but by the end of the century it became cheaper.

Most of the tea used in the world comes from China, but a good deal is sent from Japan and India, and some from Java, Ceylon, and Brazil.

The word tea is from the Chinese *cha* or *tcha*, tea.

TEAK, an East Indian timber-tree, which grows in India, Burmah, Siam, and the Malayan Islands. It is noted for size and beauty, sometimes reaching nearly 200 feet in height, with a girth of 20 to 25 feet. Its timber, of a yellowish-brown, straight-grained, and easily worked, is remarkable for weight, strength, hardness, and durability. It is used in the East for building temples and houses, but its most important use is in ship-building, for which it is considered the best timber known. Vessels built of it have lasted a hundred years, a kind of resinous oil in the wood saving it from decay and preventing iron-work from rusting. The oil is extracted from it in Burmah and used as a medicine, as a substitute for linseed oil, and as a varnish. A kind of tar also is made

from it, and a red dye is got from the leaves.

The word teak, formerly also teek, is from the Malayan *tekka*, the teak tree.

TEAZEL, the burr or head of the teazel plant, used for raising a nap on woollen cloth. The plant, which grows wild in the mild parts of Europe and Asia, is a coarse hairy or prickly biennial. The fuller's teazel, cultivated in Holland and France, which is supposed to have come from the wild kind, bears a bur 2½ inches long and 1½ inch in diameter, covered with strong, sharp hooks. These burrs, cut lengthwise into halves or quarters, are fastened to a wooden roller which revolves while the cloth passes beneath it and teazels it—that is, raises up a nap on it. Many attempts have been made to find something to do the work of the teazel, but it is considered the best thing for the purpose, because the hooks while strong enough to raise the nap, will bend or break if they come against a knot or other obstruction.

The word teasel is from the Anglo-Saxon *tæsal*, from *tæsan*, to pluck, to tease.

TELEGRAPH, an instrument to send messages to a distance by means of electricity; usually called the electric telegraph, or the electro-magnetic telegraph, because it is worked by an electro-magnet. Before the invention of the electric telegraph, messages between places were sent by means of bonfires on hills, and by the semaphore (Greek *sema*, sign, and *pherein*, to bear), a kind of telegraph consisting of a series of tall poles or masts in sight of each other, fitted with wooden arms to be used by day, and by lanterns to be used by night. A message spelled out by the arms or lanterns on one pole was repeated by the next one, and so on until it was carried to the end of the line. By means of the semaphore telegraph the escape of Napoleon from Elba was known in Paris soon after his landing on the coast. The semaphore is still used on railroads to give the signals for the block system. Ships at sea telegraph to each other by means of flags by day and by lanterns and fireworks by night.

Electric Telegraph. Though many had tried to make a working telegraph, the first practical one was constructed by Samuel F. B. Morse of New York, in 1832–35. Prof. Joseph Henry (1797–1878) of Albany, N. Y., afterward of Washington, had shown before 1831 how the electro-magnet could be used in sending signals by an electric current, and Morse used the principle made known by him. Much credit, too, is due to Alfred Vail (1807–59) of Speedwell, New Jersey, who early became Morse's assistant and helped him in making the various instruments needed. But for him and his father, Stephen Vail, who furnished the money for the experiments, Morse would scarcely have succeeded so soon in bringing the telegraph into public use. It took a long time to perfect the instruments, and many other names are connected with telegraphy as inventors or improvers: in England, Wheatstone and Cooke; in France, Ampère and Bréguet; in Germany, Steinheil and Siemens; and in America, House, Phelps, Gray, and Edison; but the Morse system is still the one in most general use all over the world.

To understand how the telegraph works the articles ELECTRICITY and MAGNET should be read before this one. The telegraph is made up of four separate parts: the generator or battery to get the electricity from; the conductor or insulated wires, by which the electric current is carried to any distance; the transmitter, or instrument which regulates the flow of electricity so as to make signals; and the receiver or register, which records the signals. The generator is made up of one or more Voltaic batteries (see ELEC-

TRICITY), each of which is composed of a number of cells connected together in a series. The Grove cell was formerly much used; then the Daniell cell; but a cell called the gravity cell, which is as good and cheaper, is now generally used. To send a message a long distance a stronge battery is needed than for a short distance. A battery can be made stronger by adding more cups or cells to it.

To telegraph from one place to another it is necessary to have a wire stretched between the two places for the electric current to flow over. Iron wire is generally used, because it is stronger and cheaper than copper. In some countries the wire is covered with gutta percha, so that the electricity cannot get away from it (gutta percha being a non-conductor), and buried in the ground; but in the United States wires are usually stretched upon high poles. As the electricity would get away and run down the poles to the earth if the wire should touch them, the wire is fastened to glass knobs, glass being also a non-conductor. The electricity, being thus kept to the wire, will flow freely between the places where the wire is stretched. But to make the current flow something else is needed. If you will look at the picture of the Voltaic battery in the article ELECTRICITY (Fig. 7), you will see that it is necessary to have two wires, one from each end of the battery, and that the two ends of these wires must be brought together before the electric current can flow round and round. It is just the same in the telegraph. Suppose that we wish to build a telegraph from New York to Washington, as shown in the picture Fig. 1, where A is the Voltaic battery in New York. From the copper plate in the right hand cup we stretch the wire B C to Washington; D being the register, or instrument at Washington which makes the signals or little marks on the strip of paper. To

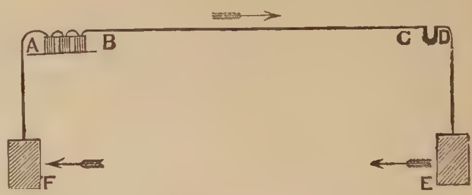


Fig. 1.—Plan of Electric Telegraph.

make the electric current flow round and round, as in the Voltaic battery in ELECTRICITY (Fig. 7), we ought to have another wire stretched back from D to A and joined to the zinc plate in the left hand cup of the battery. This would complete the circuit, as it is called, and the current could then keep on flowing round and round When the telegraph was first made it was thought necessary to have such a second wire, but it was soon found out that if the two ends of the wire were put down into the earth, the earth itself would carry the current back just as well as or even better than a second wire would. So, instead of putting up a second wire, which would add much to the cost of the telegraph, the ends of the wires at New York and Washington are now carried down into moist ground and fastened to large metal plates, as shown at E and F. The current will then flow from the battery in New York along the wire B C to Washington, thence down through the plate E into the earth, thence through the earth to F, and up to the battery at A, thus making the electric circuit complete.

This current must flow freely all the time, else we cannot telegraph, for it is by stopping it quickly and then letting it flow again that we are enabled to make the signals. When the flow of electricity round a

circuit is stopped, the circuit is said to be broken, and when it is allowed to go on again it is said to be closed.

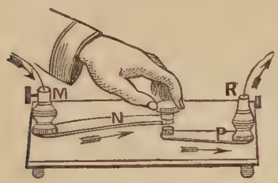


Fig. 2.—Telegraph Key.

The circuit is broken and closed by means of a little instrument called a key, shown in the picture, Fig. 2. The key is made a part of the electric circuit by the wires M and R, so that the current flowing from New York to Washington comes to it through the wire M, passes through the bar N into the bar P, and thence out through the wire R. The current will flow through only when the knob on the end of N is pressed down so that it touches P. As shown in the picture, N does not touch P, and the circuit is therefore broken, but a slight pressure of the finger will bring it down so as to close the circuit. When the pressure is taken off from N it will spring up again and the circuit will

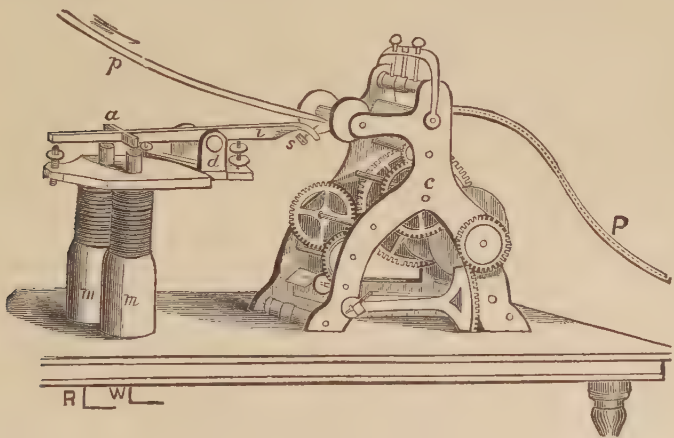


Fig. 3.—Telegraph Register.

be again broken. Thus by pressing on the key and letting it spring up again, the circuit may be closed and broken at pleasure.

Now to understand exactly how the dots and lines of the telegraph are made by closing and breaking the circuit, we must study the picture, Fig. 3, which shows the register at the Washington end of the line, marked D in Fig. 1. In this *m m* are two electro-magnets, or pieces of soft iron wound round with a great length of fine copper wire, the two ends of which are seen at R and W under the table. These ends are so connected with the wire B C (Fig. 1) that when the electric current passes from New York to Washington it enters the register by the wire R (Fig. 3), passes through the copper wires around the magnets *m m*, then out through the wire W, and thence through the earth back again to New York. While the electric current is passing through the coils of wire around the electro-magnets they are magnetic and will attract iron like any other magnet; but as soon as the circuit is broken they

lose their power and become only soft iron again. Above the electro-magnets is a metal bar *l*, which is so fastened at *d* that it can move up and down a little. When the circuit is closed so that electricity is flowing through the coils of the magnets, the end *a* of the lever is drawn down and the end *s* is pushed up. The end *s* has a steel point on it which is thus pressed against the roller under which the strip of paper passes. The paper, *p p*, is drawn slowly under this roller by means of clock-work, *c*.

Now, when the telegraph operator in New York presses on the key (Fig 2) so as to close the circuit, the magnets *m m* (Fig. 3) at the Washington end of the line become magnetic, the end *a* of the lever is attracted and drawn down by the magnets, the other end *s* is pushed up, and the steel point presses against the paper and dents a line in it. This line will be made as long as the key is kept pressed down in the office in New York; but as soon as the operator takes his finger from the key, the circuit will be broken, the magnets in the register at Washington will lose their power on the lever, the end *s* will drop down, and a blank space will be left on the paper. If the operator in New York taps on the key so as to close the circuit only for an instant, a dot will be made on the paper in Washington. It is not really a dot, but a part of a line, as shown in the table below. By pressing on the key a short time, a little longer time, or not at all, the operator can make dots, lines, or blank spaces on the paper in Washington; and by putting together lines and dots in different ways all the letters of the alphabet may be made, so that any kind of a message may be sent.

The so-called Morse alphabet was made in 1837 by Alfred Vail, whose father furnished the money to enable Morse to perfect the telegraph. This alphabet, which is still used in the United States and Canada, and in a modified form all over the continent of Europe, is made up wholly of dots and lines, the letters most used being the simplest:

A - —	N — -	1 - — — -
B — - - -	O - -	2 - - — - -
C - - -	P - - - - -	3 - - - — -
D — - -	Q - - — -	4 - - - - —
E -	R - - -	5 — — —
F - — -	S - - -	6 - - - - - -
G — — -	T —	7 — — - -
H - - - -	U - - —	8 — - - - -
I - -	V - - - —	9 — - - —
J — - — -	W - — —	0 ———
K — - —	X - — - -	. - - — — - -
L ———	Y - - - -	, - — - —
M— —	Z - - - -	? — - - — -

Multiplex Telegraphy. In 1872 Joseph B. Stearns of Boston found out how to send two messages over the same wire, one from each end, at the same time. Before this each message had to have its own wire, which added greatly to the cost of telegraphing. At first Stearns' system, called the duplex (double) system, was used only on short lines, but it is now used everywhere, even on the Atlantic cables. Two sets of telegraph instruments are connected with the wire at each end, one set being so arranged that it is sensitive only to electric signals that come out of the wire sent from the other end of the line, while the other, operated by another man, sends signals into the wire which are carried to the other end without affecting the first set of instruments.

Duplex telegraphy soon led to diplex telegraphy, invented in 1873 by Thomas A. Edison, that is, sending two messages over one wire in the same direction at the same time. This was succeeded by quadruplex telegraphy, also by Edison, or the sending of four messages, two in each direction, at the same time; and then by sextuplex, or the sending of six messages, three in each direction, at the same time. In this three different strengths of current are used, all in one direction, none of which interferes with the other, though all sent at the same time.

Next came still another advance

called multiplex telegraphy, a system by which many messages may be sent in one direction, or in opposite directions, at the same time. Thus, one wire may be made to do many times the amount of business that was possible under the old system.

Automatic Transmitter. The number of words sent over a wire in a given time by the Morse instrument is limited by the speed with which the operator can work the key. The average of a skilled operator is about twenty-five words a minute, though as many as forty-two have been sent. To increase this speed the automatic transmitter by which messages are sent automatically or by the machine itself, has been devised. The messages are sent by means of a strip of paper, with many little holes in it, by which the circuit is opened and closed, the point of the key passing through each hole as the strip moves along, and connecting with a metallic surface beneath. Several hundred words a minute may be sent by this method. The most successful apparatus of this kind is Wheatstone's.

Printing Telegraph. An instrument which prints the message in Roman letters instead of in the dots and dashes of the Morse alphabet was invented in 1847 by Royal E. House of Vermont. Others made improvements on this, among them D. E. Hughes of Kentucky, in 1856, whose instrument is much used in France. G. M. Phelps, of Troy, New York, made still further improvements, and his apparatus is now used somewhat in this country. Stock telegraphs for telegraphing stock and market quotations are printing machines. There are several kinds, the Scott, the Phelps, the Edison, and others.

Facsimile Telegraph. This instrument, by which an author's manuscript, a map, or a picture, may be telegraphed and reproduced in facsimile, works in much the same way with the automatic transmitter. In one style, called the telautograph, invented by Elisha Gray, the movements of a pen in a writer's hand make similar movements at the other end of the line, and thus produce an exact copy of the writing.

Train Telegraphing. Telegraphing to and from a railway train in motion was not made practicable until Edison and L. J. Phelps showed how it could be done. It is not necessary to have any wire connection between the train and the line of wire beside the track; for it has been found by experience that no matter how fast the train may be moving, signals upon the wire will fly across the space between it and the metal roof of the car. The operator in the train has at his ear a telephone connected by a wire with the metal roof, and thus receives any message sent to him over the wire; and by means of a telegraphic instrument held in his lap is enabled to telegraph as directly as if he were connected with the line wire. It is said that telegraphic signals between points several hundred feet apart have been received, and that Prof. A. G. Bell has telegraphed more than a mile between boats on the Potomac River. It is therefore possible that passing ships at sea may be able some day to telegraph directly to each other instead of using flag signals.

Submarine Telegraph. Telegraphing by means of wires laid under water was tried almost as soon as the electric telegraph was invented. In 1842 Morse laid a cable from the Battery in New York to Governor's Island, but it was destroyed by a vessel's anchor before he could use it. The next year Samuel Colt, inventor of the revolving pistol, laid one from Coney Island to New York, and worked it successfully. Soon after a wire was laid across the Rhine at Cologne. In 1850 a copper wire covered with gutta percha was laid between Dover and Calais, and the next year another with four wires, which worked well. Many other cables were laid in different

places, and in 1858 was made the first attempt to lay a submarine cable across the Atlantic. Messages were received for a few weeks and then the cable ceased to work. In 1866 another cable was successfully laid, and since July 27 of that year communication has not been interrupted.

There are now (1893) ten submarine cables between Europe and America, six of which start from Valentia, Ireland, two from Brest, and two from Penzance. There is also a cable from Portugal to Brazil. There are many in Europe, and several connecting Europe with different parts of Asia, Africa, and Australia, so that it is now possible to reach almost any principal part of the world by telegraph. More than a hundred thousand miles of submarine cables are now in use, or enough to girdle the earth four times. Submarine cables are now very carefully made with a core of copper wires covered with gutta percha, then with jute or hemp yarn, and finally wound with soft iron wire. The ends near shore are made much thicker and stronger than the middle part.

In telegraphing through an ocean cable a very weak battery has to be used, about as strong as is needed to ring an ordinary electric house bell. The first cable was probably destroyed by using too strong a battery, but the effect of the ocean on a cable was not understood then as it is now. With so weak a battery the ordinary Morse receiver cannot be used, and some other means had to be devised for reading the signals. For a long time a delicate magnetic needle was used, the motions of which were observed by watching a spot of light reflected on a screen in a darkened room. But as it required great skill to read such signals, and as they made no record, another instrument, called the siphon recorder, invented in 1867 by Sir William Thomson, was substituted, which makes a wavy ink-line on a tape at the rate of twenty to twenty-five words a minute. These wavy lines are as easily read by experts as the Morse signals. As it costs 25 cents a word to telegraph by the Atlantic cable, messages are usually sent in cipher, so that a single word may stand for a whole sentence. Telegraphing is now done so rapidly that one can send a message to London and get a reply within four minutes. Between ten and twelve o'clock of every business day about 800 messages pass between the stock exchanges of New York and London.

The word telegraph means far writer, being made up of the two Greek words *tele*, afar, and *graphein*, to write.

TELEPHONE. In the article MAGNET is told how currents of ELECTRICITY are made to flow through a wire wound round a steel magnet by bringing a piece of soft iron near the end of the magnet and drawing it away again. In the magnet told about there the wire is wound round it, and the two ends are then joined together. But suppose that instead of one there are two magnets, marked *a* and *b* in Fig. 1, which are separated from each other. Let the wire be first wound round the magnet *a*, then carried to a distance and wound round the second magnet *b*, and finally brought back and joined to the part around the first magnet. The electric circuit will thus be complete, so that a current excited in the coil round the first magnet will flow round the second magnet and back to the first. If the wires were connected with a Voltaic battery (see ELECTRICITY) the current would flow all the time; but if we make the current by putting a piece of soft iron near to the end of the magnet, it will flow only when we bring the iron near to and draw it away from the magnet, thus breaking up the flow into many little currents. If we use, to excite the electric current, a sheet of soft

iron, so thin that it can easily be made to vibrate, or tremble, the current will flow through the wires much like waves, which will be large or small just as the vibrations or tremblings of the iron plate are large or small.

You will remember (see MAGNET) that as a magnet will make electric currents, so electricity will make

Fig. 1.—Magnets joined by Wire.

changes in a magnet. When the magnet *a* has its magnetism changed or excited by the soft iron plate *c*, a current of electricity is caused to flow over the wire and around the magnet *b*; this current will make a change in the magnetism of the magnet *b*, like that caused in *a* by its iron plate, and the magnet *b* will act on its plate *d* and cause it to vibrate or quiver in the same way as the plate *c* was made to vibrate or quiver in front of the magnet *a*.

Now, if you can understand this you can understand how the telephone works. Next (Fig. 2) is a picture of a real telephone, with a wire stretched from New York to Philadelphia. The instruments at each end are made alike. In the New York telephone, A is the magnet, M the helix or coil of copper wire wound round a kind of spool at one end of the magnet, and C the thin plate of soft iron. You will note that the end of the magnet comes pretty close to the plate. In the Philadelphia instrument B is the magnet, H the helix, and D the iron plate. The wire between the two cities is shown in W W; but instead of being carried back again as in Fig. 1, its two ends are carried down and fastened to the plates G and G, which are buried in the ground. The circuit

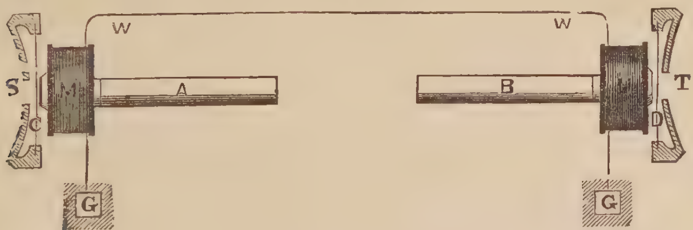


Fig. 2.—Plan of Telephone.

is thus made complete through the earth, as is told about in TELEGRAPH, and the electric current will flow round and round just the same as if the wires were stretched all round as in Fig. 1.

Each instrument has a mouthpiece, or kind of funnel, to talk into. The one in New York is shown at S, and the one in Philadelphia at T. These funnels are round (those in the picture are cut through, so as to show only a section) and have a small round hole in them, opening on to the middle of the thin iron plates, C and D. The outside of one is shown in Fig. 3. In the article SOUND is told how waves of sound cause anything to vibrate or quiver when they strike against it. Thus, when a sound is made in the mouthpiece S, the waves of sound cause the iron plate C to vibrate. These vibrations, which make the plate move backward and forward in front of the end of the magnet A, cause quivers or tremors (Latin *tremor*, a trembling) in the magnet, and these make electrical currents in the coils of wire of the helix M;

these electrical currents pass over the wire W W to the helix H in the telephone in Philadelphia, and cause the same kind of tremors in the magnet B, which carries them to the iron plate D, and it is thus made to vibrate in just the same way in which the plate C was made to vibrate by the waves of sound. These vibrations in the plate D will then strike the air near it and cause like vibrations in it, making waves of sound which will reach the ear of the person using the telephone in Philadelphia, and make just the same sound as was made in the New York instrument. Thus persons can talk backward and forward between two distant places with nearly as much ease as if they were in rooms next to each other. When the operator in New York wishes to speak to the operator in Philadelphia, he first makes a signal to him, and the one in Philadelphia puts his telephone to his ear to listen. The one in New York then puts his telephone to his mouth and talks loudly and clearly into the mouthpiece. His words set the iron plate vibrating and the vibrations are carried through the magnets and over the wires, as told above, to the iron plate in Philadelphia, which makes the same kind of sound waves in the ear of the operator there, and he thus hears every word or sound made at the other end of the line in New York. If now the Philadelphia operator wishes to answer the one in New York, he puts his telephone to his mouth and talks through it in just the same way that the New York man did through his, while the New York man puts his to his ear to listen. So the same telephone can be used to talk through and to listen with; but it is better for each operator to have two instruments, one of which he keeps up to his ear all the time, and the other he uses for speaking, thus saving the trouble of changing them.

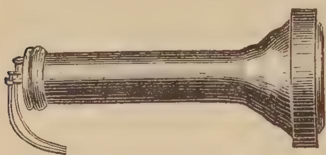


Fig. 3.—Mouthpiece of Telephone.

The telephone is now used chiefly in cities, where merchants and other people doing business with each other find it very convenient to talk between their stores and offices. There are three different kinds in use, the Bell telephone, the Gray telephone, and the Edison telephone, each named after the man who first made it. In the Bell telephone, which is much used in New York, the mouthpiece, like the one in the picture (Fig. 3), commonly called the "phone," is put to the ear only, the instrument to talk through, which is called the transmitter, being made like a little box, and fastened to the wall. The person using this telephone stands in front of the transmitter, with the phone to his ear, and talks in his common voice, but speaking plainly. A conversation can thus be easily carried on at almost any distance. People now talk freely between London and Paris, and in the United States telephonic intercourse is easily kept up between Portland, Maine, and Buffalo, New York, a distance of about 750 miles.

All kinds of sounds can be sent over telegraph wires by means of the telephone. Thus the voices of people singing and the music of a piano or of any other instrument can be heard hundreds of miles away. A concert given in Philadelphia has been plainly heard in New York, and a man whistling in Paris has been heard in London.

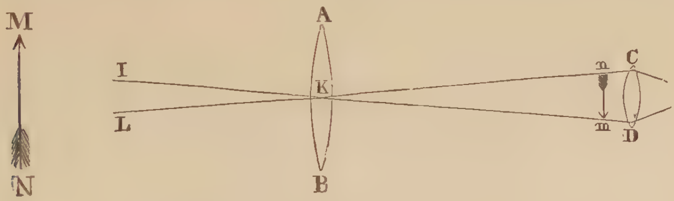
Like the telegraph, the telephone was of slow growth. Many had tried to find out how to convey sounds by electricity, among them Wheatstone in England, Reis in Germany, and Page, Dolbear, Gray, and Edison in America; but the first practical telephone was made by Alexander Graham

Bell, a native of Edinburgh, but living in Boston, Massachusetts. In 1876 he exhibited at the Centennial Exhibition in Philadelphia an apparatus by which words were conveyed to a distance, and he is now considered the real inventor of the telephone. Many improvements have since been made by Edison, Gray, Hughes, Blake, and others, and different kinds of transmitters are used in different countries, but the principle is the same in all. More than 300,000 telephones are now in use in the United States.

The word telephone was first used in 1861 in a lecture by Philip Reis in a lecture delivered in Frankfort, Germany. It means far talker, being made up of two Greek words—*tele*, afar, and *phone*, voice, sound.

TELESCOPE, an instrument to aid us in seeing things at a distance. When we try to look at anything afar off the image which the rays of LIGHT from it make in the eye is too small to be clearly seen. Much of the light from it, too, is lost in its passage through the air, so that fewer rays reach the eye. But by the aid of a telescope we are enabled to collect the rays and to make an enlarged image of the object so that we can see it much better.

There are two kinds of telescopes: the astronomical, used by astronomers to view the planets and stars; and the terrestrial, commonly called a spy-glass, used for looking at distant things on the earth. The astronomical telescope is made up chiefly of a LENS, or round glass



Lenses of Astronomical Telescope.

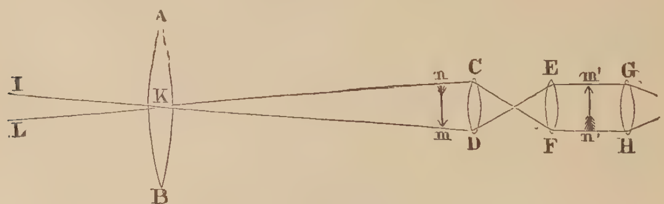
called an object glass, which forms an image of the distant object, and of an eye glass which magnifies or enlarges this image. The lenses are fitted into a long tube, which keeps out rays of light from other things when the eye is looking through it. In the picture, where only the lenses are shown without the tube, A B shows the object glass, and C D the eye glass. The arrow marked M N is a distant object, from which the rays of light I K and L K fall on the object glass and form on the other side of it the image *n m*. The image thus brought near is looked at by the eye through the lens C D, which magnifies it so that it can be seen clearly.

As will be seen in the picture, this image is upside down, but this is of no consequence in viewing the heavenly bodies, which are round. In looking at distant things on the earth, however, it would be very inconvenient to see them upside down; so two other lenses are put into spy-glasses, and the rays of light from the image made by the object glass are passed through these and the image is thus turned upright. In the second picture, C D and E F are these two glasses. The rays from the image *n m* pass through these glasses and form a new image *m' n'*, which is magnified by the eye glass, G H, in the same way as in the other telescope. The tubes into which the glasses of terrestrial telescopes are put are usually made to shut up. The kind of telescopes shown in the first two pictures are called refract-

ing telescopes, because the image of the object is formed by refraction through an object glass. (See LIGHT.)

Another kind of telescope used for looking at the heavenly bodies is called a reflecting telescope, because the form of the distant object is reflected in a mirror, and the image thus made is looked at through a magnifying glass. The tube of such a telescope is made very large, and is open at the end which is pointed at the object to be looked at. In the third picture, which shows the great telescope used by the astronomer Herschel, A A is the tube, with the mouth open toward the object looked at, M N. The other end of the tube is closed by the mirror, B B, whose face is concave, that is, hollowed out, so that the image which M N makes in it is reflected to C C. At E is a small tube, fitted into the mouth of the large one, and having in it an eye glass, which magnifies this reflected image, so that it looks very large and clear to the eye. The one who looks into this telescope has his back toward the object looked at. Some reflecting telescopes are made differently, but the principle is the same in all.

The largest reflecting telescope in the world is that constructed by Lord Rosse in Ireland, the tube of which was six feet (72 inches) in diameter and fifty-five feet long. A similar one made by Sir John Herschel, was about two-thirds as large. It is not used now, but its great tube is preserved set up on three



Lenses of Terrestrial Telescope or Spy-Glass.

stone pillars at Sir John's residence in England. When it was taken down from its stand in 1839, all the family sat in it and sang a farewell song.

The size (diameter) of the principal reflecting telescopes in the world is shown in the following table:

Lord Rosse's,	72 inches
Melbourne,	48 "
Paris,	47 "
Mr. Common, England,	37.5 "
Lord Rosse, (2d one)	36 "
Toulouse,	32.4 "
Marseilles,	31.5 "
Greenwich,	28 "
Harvard University,	28 "
Cambridge, England,	24 "

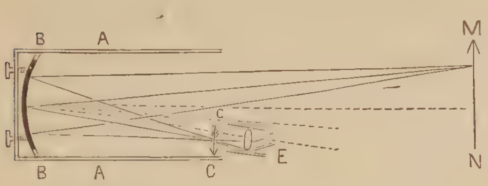
The principal refracting telescopes in the world are:

Lick Observatory, Cal.,	36 inches
Pulkowa, Russia,	30 "
Nice, France,	29.75 "
Yale University,	28 "
Vienna,	26.75 inches
U. S. Naval,	26 "
Leander McCormick,	26 "
Chamberlain Obs., Univ'ty of Va.,	26 "
Gateshead, near London,	25 "
Paris,	23.6 "
Princeton College,	23 "
Denver, Col.,	20 "
Dearborn Obs., Evanston, Ill.,	18.5 "
Carleton Coll., Northfield, Minn.,	16.2 "
Warner Obs., Rochester, N. Y.,	16 "
Washburn Obs , Madison, Wis.,	15.5 "
Harvard University,	15 "

A glass 46 inches in diameter is now making for a new telescope soon to be placed in the observatory of the University of Chicago.

History. It is not known who made the first telescope. There are some reasons for thinking that Roger Bacon, an English philosopher, who died about 1294, understood the principle of it; but, if he did, he did not put it into practice. Its practical discovery was made in Holland about

1608 by one of three men, named Lippershey, Jansen, and Metius; most probably by Lippershey, who was a spectacle maker in Middelburg. Telescopes soon found their way all over Europe. Galileo heard of the invention when in Venice in 1609, and setting to work made a telescope for himself without having seen one. For this he was rewarded by the senate, and as he greatly improved the instrument and made it much more powerful than the original ones,



Reflecting Telescope.

he got the credit of the invention. Since Galileo's time the telescope has been improved in many ways, and it is now a very different instrument from what it then was, though the general principle is the same.

The word telescope means far-viewer, being made up of the two Greek words *tele*, afar, and *skopein*, to view or see.

TERRAPIN, a kind of tortoise, found principally in America. There are several kinds, but the diamond-back is the most important one. It is common along the Atlantic coast from Massachusetts to Texas, and is found also in South America; but those sold in market come chiefly from Chesapeake Bay and the coasts of Carolina and New Jersey. The diamond-back lives in salt marshes along the sea-coast, where it feeds on both animal and vegetable food. It is about seven inches long and weighs four or five pounds, though some reach ten inches and weigh ten pounds. In winter it buries itself in the mud and remains till spring, eating nothing. Unfortunately for its welfare, it leaves a little mound of mud above the spot, which the terrapin fishermen well know, and many are captured while in this condition, though most are caught in the summer and penned up in yards called crawls, and kept until the market season opens. While thus penned they are fed on crabs, oysters, and fish; and on celery, which is said to give them the finest flavor. Terrapins are prized for food and command high prices. They are cooked in a kind of stew with eggs, cream, butter, and spices, with a little wine when ready for table.

The word terrapin is supposed to be of American Indian origin.

THERMOMETER, an instrument for measuring heat. In the article HEAT it is told that all things, whether solid, liquid, or gaseous, are made larger by adding to their heat; and that when heat is taken away from them they grow smaller again. It takes a great deal of heat to make a solid change much in size, and gases grow much larger with a very little heat; so liquids, which act between the two, are found to be the best for thermometers. Thermometers are usually made of a glass tube filled with MERCURY. If the glass and the mercury, one of which is a solid and the other a liquid, grew in size alike in the same amount of heat the mercury would never rise in the glass tube. But with the same heat mercury swells seven times as much as glass does; therefore, when it is warmed it rises up in the tube to find room for itself, and when cooled it sinks down again.

In making a thermometer a small glass tube, with an even hole through it, is selected. If the hole be not of the same width all the way through, the mercury will not rise evenly in it, so great care has to be taken to get a good one. Only

about one in every six of those made is found to be even. The bulb, or little round ball at the lower end, is then made by melting the end of the tube and blowing it (see GLASS). The next thing is to put the mercury into the bulb, but as this cannot be done while it is full of air, the bulb is heated so as to swell the air and drive some of it out. The open end of the tube is then put into a dish of mercury, and as the air cools again it shrinks and some of the mercury rises up and partly fills its place. The mercury in the bulb is then boiled, which makes it swell up so as to drive out the rest of the air; and as the open end is still kept in the mercury, when the bulb cools the mercury in the tube shrinks and more mercury runs up and fills the tube full. The bulb is then put into some liquid heated a little hotter than the highest heat which the thermometer is meant to show. This makes the mercury swell and run out of the top of the tube, and when it stops running over, the glass is melted with a BLOWPIPE flame and the end sealed up. As the mercury cools it sinks down little by little in the tube, leaving a vacuum or empty space above it.

In order to tell just how much heat it takes to make the mercury swell and rise up to any point in the tube, a scale of figures has to be fastened to it, on which the freezing point and the boiling point of water are marked. The freezing point is the heat at which ice begins to melt, and the boiling point is the heat at which water boils. To find the freezing point, the bulb and tube are surrounded with melting ice, and the place in the tube where the mercury stops is marked. The boiling point is then found by putting the bulb and tube into the steam of boiling water, and marking the place at which the mercury stops. The space between these two points, and the part below the freezing point, are then divided up and marked with figures.

There are several kinds of thermometers, in which the scale of figures is made differently. In the common thermometer, called Fahrenheit's because it was first brought into use by a man of that name in Holland about 1720, the freezing point is marked 32 and the boiling point 212. What is called zero is marked 0 on the scale, and is therefore 32 degrees below the freezing point. The Fahrenheit thermometer is the one most commonly used in England and the United States, but in most countries in Europe the centigrade thermometer is generally used. In this the freezing point is marked 0, and the boiling point 100. Thus there are just 100 steps between the two points, and it is from this that it gets its name of centigrade (Latin *centum*, hundred, and *gradus*, step). Still another thermometer, called Reaumur's, because first made by a Frenchman of that name, in 1730, has the freezing point marked the same as in the centigrade, but the boiling point is marked 80. This thermometer is used in Spain and in some parts of Germany.

As mercury freezes at about 39 degrees below the zero point of Fahrenheit's thermometer, alcohol colored red is used in thermometers for very cold places. More than 100 degrees below zero can be measured in an alcohol thermometer. Very great heat is measured by an instrument called a pyrometer, in which the heat is marked by the swelling of heated bars of iron and other metals which move a pointer on a kind of clock face.

The word thermometer means heat measure, being made up of two Greek words, *therme*, heat, and *metron*, measure. Pyrometer is made from the Greek *pur*, fire, and *metron*, measure.

THIMBLE. A silver thimble is a very small thing, but it takes more

than twenty men, besides a good deal of costly machinery, to make one. In the first place the silver, which comes to the factory in bars, is passed through great steel rollers, which roll it into sheets so thin that it would take twenty of them to make an inch high. The sheets are cut into strips about two inches wide, that look like silver ribbons, and out of them another machine punches round pieces about as large as a silver half-dollar. These round pieces, or blanks, as they are called, are next fed one by one to a machine which turns up the edge all round to make the rim, and are then put into a press where a steel die comes down with a smash and gives the thimble its proper form all at once. It is now of the right shape, but is smooth and has no dents in its top. To make these the thimble is put into a LATHE, and while it is whirling round, a workman, who sits in front of the lathe with a tool shaped somewhat like a hammer, puts a dent in the middle of the top, then a ring of dents round it, then another ring, and so on until all the dents are in. The thimble is then polished, has a number marked on it, and has the border of leaves or figures usually seen on thimbles, engraved or stamped around its base.

Gold thimbles are made of steel, and have only a thin coating of gold on them. They are made in much the same way, as are also brass and steel thimbles; but brass and steel thimbles are sometimes made without any tops. Thimbles are also made out of hard India-rubber, and sometimes even out of ivory and china. Thimbles have been in use only about two hundred years. It is not known who first made them, though some think they came from Holland.

The word thimble is changed from the Old English thumb-bell. Anglo-Saxon *thymel*, from *thuma*, thumb. The Germans call the thimble *finger-hut*, finger-hat.

THRUSH. Thrushes are found in all parts of the world, and among them are some of the best of the singing birds. They live on insects, worms, and berries, make their nests usually on trees or bushes, and lay five or six eggs.

The **Brown Thrush**, or thrasher, as it is commonly called, is one of the most common American kinds. It is handsomer than the mocking-bird, being bright reddish-brown above and yellowish-white below, marked with dark brown spots shaped like an arrow head, and having black legs. Its habits are much like those of the mocking-bird, and it ranks next to it as a singer. In the spring when the female bird begins to rear her young, the sweet warble of her mate is heard above the voices of all other singers in the northern forest. It can be tamed as easily as the mocking-bird, and soon becomes cheerful and familiar, flying to its master when let out of the cage, perching on his shoulder or finger, and even following him around; but it is jealous of rivals and will drive other birds away. It is very bold and will fight anything that comes near its nest. It usually lays pale buff eggs, marked with small brown spots. When kept in a cage it may be treated like the MOCKING-BIRD.

The **Wood Thrush** is also a sweet singer, but it has not so many notes as the brown thrasher. Its plumage is reddish-brown above and white spotted with black on the breast. Its eggs are light blue.

The thrush belongs to the order *insessores*, or perching BIRDS, and to the same family with the American robin, mocking-bird, cat-bird, and European blackbird.

The word thrush is from the Anglo-Saxon *thrysce*, thrush.

THYME, a small plant of the mint family, which grows wild in southern Europe, but is much cultivated here in gardens for its fragrant leaves. It is used for flavoring soup,

stuffing, and other cookery. Oil of thyme, which is distilled (see ALCOHOL) from it, is used in liniments.

The word thyme is from the Latin *thymum*, Greek *thumos*, which is from *thuein*, to burn incense, and the plant is so called because it was used for INCENSE.

TICK, a kind of mite, belonging to the spider family, that lives on the blood of animals, including man. There are many kinds in woods and fields, called wood-ticks, dog-ticks, cattle-ticks, etc., that fasten upon animals, burying the head in the skin and sucking the blood until they swell up and drop off. They are troublesome, but not dangerous.

The tick belongs to the second class of articulate ANIMALS.

The word tick is from the Anglo-Saxon *tica*, a tick.

TIDES. In the article EARTH is explained the attraction of gravitation, and in the article UNIVERSE is told how this rule of attraction extends all through the universe. Thus, while the waters of the ocean are kept upon the earth by attraction, they are also drawn toward the sun and the moon by a similar force. Now, some parts of the earth are nearer the attracting bodies than others, and are therefore more strongly attracted. This makes an inequality which causes a motion in the waters of the ocean. As the earth turns daily on its axis different parts of its surface are brought in succession under the moon and thus the waters are made to rise and fall daily according to the position of the moon. This motion of the waters is called the tidal wave. If the ocean covered all the earth, the motion of the tidal wave around the earth would be continuous and uniform; but as its course is obstructed by continents and islands, by the shape of the bottom of the sea, and by other causes, the tidal wave differs greatly at different places, and we have to depend on observations taken at those places to understand exactly its motion.

As the moon is nearer than the sun to the earth, it exerts the greater force, the attraction of the sun being about four-tenths that of the moon. At new moon and full moon these two forces act together, and the actual force is equal to their sum. The tides are then higher than usual and are called spring tides. When the moon is in its first and its last quarter, the sun and moon act in opposite directions, the sun tending to make a high tide and the moon a low one, and *vice versa*. The tides are then lower than usual and are called neap tides.

The rising of the tide is called the flood, and its highest elevation high tide or high water; the falling is called the ebb, and the lowest depression low tide or low water. The tides of each day occur a little later than those of the day before, the average difference being about fifty minutes. The height of the tide varies greatly at different places: thus, at New York the rise and fall is from $3\frac{1}{2}$ to $5\frac{1}{2}$ feet, at Boston $8\frac{1}{2}$ to $11\frac{1}{4}$ feet, at St. John's, New Brunswick, 19 feet, and at Sackville in Cumberland Basin, 36 to 50 feet at spring tides.

The word tide is from the Anglo-Saxon *tid*, time or opportunity.

TIGER. The tiger is found only in Asia. It is usually about eight feet long and three or four feet high, but some much larger ones have been seen. It is more graceful in form and more active and stealthy in its movements than the lion, has a smaller head, and no mane. Its color is a bright tawny yellow above and white beneath, striped with brown bands and bars. Its tail, which is very long, is ringed with black. The tiger sleeps by day in some shady spot among the jungle or brushwood and seeks its prey by night. It often lies in wait near springs for animals that come to drink. It can run very fast, can leap more than three times the length of

a man (15 to 20 feet) at a bound, and is able to carry off an ox.

Tigers are the terror of villages in India, from which they carry off many cattle and human beings. When hungry they will get food, no matter what danger stands in the way, but they never kill for the mere pleasure of killing. A tiger has been known to carry off a soldier from the middle of a camp, and even to seize a man in broad daylight from among a crowd of men. Once at the fair of Hurdwar, in India, where a great many were gathered together, a tiger sprang out of a thicket near by and carried off a man in the sight of all the people. Formerly tigers carried off hundreds of people every year in India, but they are not so plentiful now in the thickly settled parts as they used to be.

Tiger hunting is a favorite sport in the East. The hunters ride in a kind of carriage or house on the backs of elephants and shoot the tigers with rifles. There is much danger in this, for a tiger will sometimes spring upon the elephant and hurt some of the hunters. Many tigers are caught in traps baited with a live goat or sheep, and sometimes heavy beams are so placed that they will fall and crush them when they walk along a path. Bows which shoot poisoned arrows are sometimes so fixed in their path that they will go off when touched. In China a large box-trap with a looking glass is set with the door open. The tiger, seeing his own image in the glass, and thinking it to be another tiger, goes in, and the door closes and he is caught. This kind of trap is very old, it being shown in ancient sculptures. In some parts of India tigers are killed in a still more curious way. Many broad leaves smeared with a kind of glue like birdlime are strewn in the tiger's way. When he steps on any of them they stick to his paws; he rubs his paws on his head to get them off, and the leaves stick to his face; the harder he works to get them off the worse he gets stuck up until he gets blinded and rolls on the ground howling with rage. The hunters hear the noise and come and shoot him.

The tiger can be tamed, and will sometimes show much love for its master and for those who take care of it. Almost everyone has seen the so-called lion tamers, Van Amburgh and others, go into the tigers' den in menageries and play with the animals as if they were common cats, A tiger which was being brought on a ship from India to Europe became so tame that it was allowed to wander about in all parts of the vessel, and the cabin boys used to sleep with their heads on it for a pillow.

The historian Pliny says that the first tiger taken to Rome was a tame one which belonged to the Emperor Augustus. When Heliogabalus became emperor, he rode into Rome in a chariot drawn by four tigers and four panthers, all of which were so tame that they used to run all about his palace. The cruel Emperor Nero had a tame tigress that he kept near him. Sometimes, at the end of a feast, he would point out to the animal someone at whom he was angry, and in a moment the bleeding body of his enemy would lie at his feet.

The tiger is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the cat family, to which belong also the LION, LEOPARD, PANTHER, COUGUAR, JAGUAR, LYNX, and common CAT.

The word tiger is from the Latin and Greek *tigris*, tiger.

TILE, a plate of baked clay for covering floors and roofs, for making drains, etc. In making tiles the best kinds of brick clay are used, and the process is similar to that of brick-making. Tiles for floors and for ornamenting fireplaces, hearths, and walls are decorated, painted in colors, and glazed before baking. About the middle of the eighteenth century it was found out how to transfer designs by printing from

paper, and since then tiles have been made much more elaborate in pattern than before.

Roofing tiles are of two kinds, plain or flat tiles, and pantiles or curved tiles, both of which are laid so as to overlap and carry off the rain. The Egyptians used roof tiles made in the form of half a cylinder, one row being laid with the concave side up and the next with the convex side up, the edges fitting in the lower ones. The Greeks and the Romans used large flat roofing tiles.

The Assyrians used tiles or tablets of baked clay to write upon, forming their cuneiform or wedge-shaped characters on them while soft, with a stylus, and baking them afterward. The Egyptians used them in a similar way, but wrote on them with ink.

The word tile is from the Anglo-Saxon *tigel*, from Latin *tegula*, a tile, from *tegere*, to cover.

TILE-FISH, a new kind of fish discovered in 1879 off the coast of Massachusetts. It is quite large, weighing from 10 to 50 pounds, and is one of the most beautifully colored fish known out of the tropics. Its general color is bright yellow and it is marked with spots like a leopard, whence it was first called the leopard fish.

Tile-fish were found in great numbers in deep water (80 to 250 fathoms) about 80 miles southeast of Noman's Land, and it was thought that they would prove to be almost as valuable as the codfish; the flesh being fine-grained and delicate, resembling both the cod and the striped bass. But in 1882 millions of them were found dead floating on the ocean by steamers coming in to New York, and they are supposed to have been almost or quite exterminated by some unknown cause.

The tile-fish is so called because its sides look somewhat like a painted tile.

TIN, a METAL, one of the principal ELEMENTS. When pure, it is almost as white as silver, is softer than gold and harder than lead, and may be hammered into thin plates and drawn out into wire. The tin of trade is never quite pure, but has in it a little iron, lead, or ARSENIC. Its principal ore, called tinstone (tin oxide) is made up of tin and OXYGEN. It is heated in furnaces with charcoal; the CARBON of the charcoal unites with the oxygen, and makes carbonic oxide gas, which goes off into the air, and the tin melts and is drawn off and cooled in iron moulds. Tin thus made is called block tin. The principal places in the world from which tin ore is got are Cornwall in England, Banca in the Dutch East Indies, Malacca, and Queensland and New South Wales in Australia. Some is found also in Peru, in Mexico, and in the United States, in Missouri, California, and Dakota. Tin is used in the arts for making tin-FOIL, for covering other metals, and for making ALLOYS. It is used to cover other metals on account of its brightness and because it does not rust at the common heat of the air. Copper and brass are often coated with it, as in PINS, kettles and other vessels for cooking, bath tubs, etc., but its chief use is in tinning thin iron plates for tin-ware. The iron is rolled out into thin sheets, thoroughly cleaned with weak acid, and then dipped into melted tin and allowed to stand in it for an hour or more, when the tin unites with the iron, making a thin coating over the whole surface. Bridle bits, stirrups, tacks, and small nails are tinned in the same way. Saucepans and other hollow vessels are tinned by pouring melted tin into them and turning them round and round until the tin has touched every part of the inside.

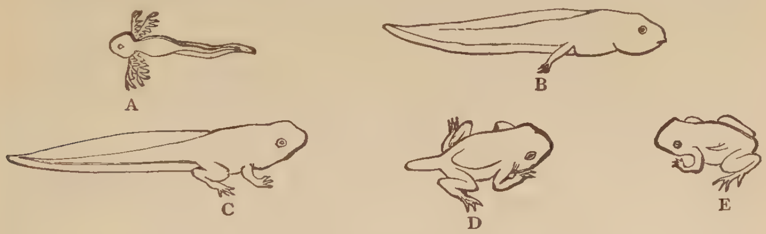
History. Tin was known and worked at a very early period. Brass, which is made up of copper and tin, was largely used at Tyre at least 1000 B. C. The Phœnicians got much of their tin from the

British Isles, and the Greeks followed them in the trade. When the Romans conquered Britain they worked the Cornwall mines by means of slaves, and most of the tin used came from there until other mines were discovered in Bohemia in 1240, in Saxony in 1458, and in Barbary in 1640. In 1760 tin from Banca in the East Indies began to be sent to Europe. Australian tin was discovered in 1872.

The ALLOYS of tin are important. Those formed with copper are told about under BRONZE. Among those formed with lead are Britannia metal, queen's metal, PEWTER, and SOLDER.

The word tin is Anglo-Saxon.

TOAD. Toads differ from frogs in several ways. Frogs have teeth in the upper jaw, but toads have none at all. Toads' legs are shorter than those of frogs and they therefore cannot leap so far; and as they have no webs between their toes, they cannot swim so well. They live mostly on land, going into the water only in the spring to lay their eggs. Their tadpoles grow up in the water just as those of frogs do. The body of the toad is covered with a thick warty skin, from which a kind of white juice having a bad smell oozes out. Though this is not poisonous it is apt to make a tender skin smart, and a dog will drop a toad from his mouth very quickly. The toad's skin comes off every year in two pieces, which are swallowed by the animal. Toads lie numb during the winter in holes in walls or under logs



Growth of the Toad, showing its changes.

and stones. In warm weather they usually hide away during the day in shady places, and come out at evening in search of food. They are very useful in gardens in destroying grubs and insects; in the market gardens around London they are bought for this purpose, and they are often put into hot-houses to rid them of ants.

Toads, like frogs, lay a great number of eggs. These are generally in two long strings, enclosed in a jelly-like substance, and are usually hatched in about ten days. Like frogs too, toads pass, after hatching, through wonderful changes, which are shown in the picture. The tadpole, which is smaller than that of the frog, has at first a tail but no legs, and breathes like a fish through gills, of which it has two pair as seen in A. After a while the hind legs begin to grow, as in B, and then the fore legs come out, as in C. With the growth of the legs the body gradually becomes smaller and the tail shrinks until it becomes as in D, and finally the full-formed little toad, as in E, with its gills changed into lungs, leaves the water and hops about an air-breathing land animal. The toad has been known to live thirty-five to forty years. It can be tamed so as to know one who is kind to it, and may be taught to eat from the hand.

The toad belongs to the class AMPHIBIA, or animals which live both in water and on the land.

The word toad is from the Anglo-Saxon *tadie*, toad.

TOBACCO, the dried leaves of an annual PLANT, belonging to a group of plants called *nicotiana*, after Jean Nicot, a Frenchman who sent the seeds from Portugal to France in 1560. There are many kinds of tobacco, all of which grew first in America. When the Spaniards landed in Santo Domingo in 1492 they found the Indians smoking the leaves of this plant, which they grew for this use. All the Indians of North America, from Canada southward, smoked tobacco; but the natives of South America did not smoke, though they chewed tobacco and used it as snuff. The Spaniards learned to use it, and it was soon carried to Europe and thence to Asia, probably by the Portuguese, and is now cultivated in warm and mild climates all over the world. Tobacco is raised in the United States in all the States and Territories excepting Idaho, Nevada, Rhode Island, Wyoming, Oklahoma, and Utah. Kentucky produces more than four times as much as any other State. After it come, in order of production, Virginia, Ohio, North Carolina, Tennessee, Pennsylvania, Wisconsin, Maryland, Missouri, New York, Connecticut, Indiana, Illinois, Massachusetts, West Virginia, Arkansas, and Florida.

The tobacco plant grows sometimes as tall as a man, though it is usually but little more than half as high. It has large broad pointed leaves, covered with fine hairs, and bears a cluster of purplish pink flowers on a stalk. But only tobacco meant for seed is allowed to blossom, the flower bud being always broken off in that to be dried. When fully grown the plant is cut off just above the ground and hung up to dry, head downward, in buildings open at the sides so that the air can pass through. After about three months the leaves are stripped from the stems, separated into three or four different kinds, and packed in boxes or casks for sale. When the tobacco reaches the manufacturer the first thing done is to pull out the stems which run through the middle of the leaves. The stems are not good for much, but are used in making cheap snuff and poor kinds of cut tobacco. The leaves are made into CIGARS, chewing and smoking tobacco, and snuff. In making chewing and smoking tobacco the leaves are sweetened, colored, and flavored with molasses, licorice, salt, soda, saltpetre, aniseed, etc. Cut tobacco is cut into shreds in machines which work somewhat like a hay-cutter. Snuff is made by grinding the leaves to a fine powder. For some kinds of snuff the leaves are dried in kilns, and for others they are ground when moist. Snuffs are colored and flavored with various things.

The word tobacco is from *tabaco*, the name given by the Indians of Santo Domingo to the pipe in which they smoked it.

TOMATO, the fruit of an annual PLANT of the nightshade family, which first grew in the warm parts of America, but is now cultivated in all parts of the world where the climate is suitable. The first tomatoes were brought from Peru, as is shown by the name given them—*Mala Peruviana*, Peruvian apples. The plant is found wild in Mexico also. In old times tomatoes were grown in gardens chiefly as curiosities, and were called love-apples. They were first sold for food in the New Orleans markets about 1812, and in Philadelphia in 1829. They were raised in New England in 1832, and three years later were sold in Boston markets. There are more than sixty kinds, which differ in size, shape, and color, but the large red ones are most cultivated for market. Tomatoes are eaten either raw as a salad, or cooked in various ways. They are also pickled and preserved, and made into catsup. Great quantities of them are put up in tin cans every

year for winter use. The earliest tomatoes in our markets are brought from the Bermuda Islands.

The word tomato is from *tomatl*, the Mexican Indian name of the plant.

TOPAZ, a PRECIOUS STONE, made up of alumina (see ALUMINUM), silica (see SILICON), and other things. It is usually colorless like glass, but is sometimes yellow, red, blue, or green. The white or colorless topaz is often cut like the diamond, and looks much like it, but is easily scratched by the diamond. This and the rose-red kind are the most valuable, but no topazes sell very high. The best are brought from Brazil. The topaz is next to the sapphire in hardness. What is called the oriental topaz is not a real topaz, but a SAPPHIRE. It is of a beautiful deep orange-yellow color, and is very valuable.

The topaz is named, Pliny says, from the island of Topazos, in the Arabian Gulf, where the Romans got topazes.

TORPEDO. The first practical experiment with a torpedo for blowing up a ship was made by David Bushnell of Connecticut, a captain in the American army in the Revolutionary War. He devised in 1776 a torpedo charged with gunpowder, to be fired by clockwork, which was to be carried by a man in a submarine boat and fastened on the bottom of a ship. It was tried on Lord Howe's ship, the Eagle, in New York Harbor, but it was found impossible to fasten it properly, and it floated away and exploded harmlessly. Bushnell afterward tried others, but they did not succeed, though they frightened the British. In 1804 and 1805 Robert Fulton made experiments in France and England, and in 1807 in New York with some success. He made several kinds of torpedoes, one kind to float in the water when anchored, to be fired by a ship coming in contact with it; another to be fired from a gun and stuck on to a vessel's side by a kind of harpoon; and a third to be carried on the end of a spar in front of a vessel. Samuel Colt, the inventor of the revolver which bears his name, was the first to explode torpedoes by electricity. In 1836 he invented a method of protecting harbors by a series of floating torpedoes connected by wires with the shore, to be fired by electricity. Torpedoes were used to some extent in the Crimean War, in our Civil War, in the Franco-German War of 1870–71, and in the Russo-Turkish War of 1877.

Torpedoes may be divided into two classes; defensive torpedoes, for the protection of harbors and rivers, and offensive torpedoes, to be used in battles between men-of-war.

Defensive Torpedoes. These may be either floating iron cases filled with gunpowder, gun cotton, or some other explosive, anchored just under the surface of the water in channels where ships have to pass, and so arranged as to be fired by the touch of the vessel itself; or submarine mines laid on the bottom, to be exploded by means of electric wires when the vessel is over them.

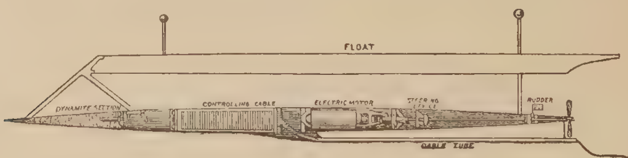
Offensive Torpedoes. The most simple kind is the spar torpedo, carried on the end of a long spar on the bow of a boat, and so made as to explode when it strikes against an enemy's side. Such a torpedo was used by Lieut. Cushing when he blew up the Confederate ram Albemarle in 1864. As now made, the end of the spar is dropped so as to strike the enemy about ten feet under water, and the torpedo is then exploded by electricity.

But the principal torpedoes used in war are those which can be sent out alone against an enemy. There are two kinds: 1, the dirigible torpedo that is directed and steered from a vessel or from shore by means of an electric wire; and 2, the automobile (self-moving) or fish torpedo, which steers itself.

1. The Sims-Edison torpedo,

invented by W. Scott Sims, and driven by an Edison electric motor, is about 30 feet long and 24 inches wide. It is in two parts, as shown in the figure; a copper float, which floats just under the surface, fitted with two standards which appear above the water so that its course can be seen by those controlling it, and the torpedo itself, which is suspended by steel rods about six feet beneath the float. The torpedo carries in its head 270 pounds of dynamite. Back of it is the wire cable on a reel which unrolls as the torpedo advances, the wire being carried in a cable tube past the propeller behind, so that there is no danger of getting tangled about it. In the middle is the motor which drives the propeller. The wire is more than a mile long. When the torpedo is sent out against a ship, the person guiding it can steer it in any direction or stop it if he chooses. If it strikes against a ship, an electric signal tells him and he then presses a button and fires the charge. The Patrick torpedo, invented by an American (sometimes called also the Long, the Hargin, and the Wood torpedo, from improvements made by different persons) is somewhat like the Sims-Edison in shape, having a copper float holding the torpedo beneath. It is controlled, too, by an electric cable which runs out from a reel as it goes; but its engine is driven by carbonic acid gas instead of electricity. It carries 200 pounds of explosive material. This torpedo, intended chiefly for harbor or coast defence, has been adopted in France.

2. The Whitehead torpedo, invented by Robert Whitehead of England, is a fish torpedo which swims under water by itself without any wire to direct it from shore. It consists of a cigar-shaped vessel of steel or bronze, about 14 feet long, divided into several compartments: in front the magazine, filled with discs of gun-cotton; next a compartment containing the machinery which keeps it at the right depth under water; third, the reservoir for compressed air, which drives the machinery; fourth, the machinery; fifth, an air-tight chamber which will fill with water and sink the torpedo if it fails to explode; sixth, a contrivance to make the two propellers revolve in opposite directions; and seventh, the two rudders. When the torpedo is started, it drops to a certain distance under water and moves very fast in the direction in which it is pointed. If it hits the vessel the charge of explosive in its head is fired by percussion. In the Chilian war in 1891, the Blanco Encalada, a large armored ship belonging to the Congressional party, was sunk in the port of Caldara by a Whitehead torpedo sent out from a torpedo vessel. The Whitehead is used in almost all European navies.



The Sims-Edison Torpedo.

The Victoria torpedo, invented by Read Murphy of Melbourne, Australia, and named after his colony, is an improved Whitehead, steered from shore or from a vessel by means of an electric wire, like the Sims-Edison and the Patrick.

The Howell torpedo, the invention

of Capt. J. A. Howell, United States Navy, also a fish torpedo, is smaller than the Whitehead, and is thought by some to be better.

Torpedo Boats. The use of torpedoes in war has made necessary torpedo boats, built especially for torpedo service. Some are large, for sea service, some are for harbor and coast defence, and some are small vessels, like steam or electric launches, to be carried on the decks of men-of-war and put into the water when needed in a naval battle. All are built for speed, and are fitted with tubes for firing torpedoes by either compressed air or small charges of gunpowder. Foreign nations have many such vessels, and they are considered very important in modern warfare, especially for harbor and coast defence and for attacking a blockading fleet. The Russian torpedo vessel Wiborg, 142 feet long, carries three torpedo tubes, each 19 feet long, two to fire torpedoes through the bow, which is protected with armor, and one from the deck. She can steam 20 knots an hour.

To guard against the attacks of torpedo boats and of torpedoes, foreign nations are building also boats called torpedo-catchers, of even greater speed than torpedo boats, fitted with rapid-fire and machine guns and torpedoes to destroy them. War-ships are protected, too, against attack at night by powerful search-lights that light up the sea to a great distance, and by steel nets which can be let down into the water so as to catch a torpedo before it gets near them. Some naval men think that the torpedo will in time overcome the armored ship and render it almost impossible for one to approach a hostile shore.

Submarine Boats. Boats made to go under water and discharge torpedoes have been tried many times since Bushnell first used them in 1776, but not with much success. During the Civil War a submarine boat 35 feet long, with a propeller worked by eight men and a ninth to steer, went out of Charleston harbor and sunk the United States steamer Housatonic. The torpedo boat is supposed to have been itself destroyed by the torpedo, as it never returned. In 1885 a cigar-shaped submarine boat, worked by steam, invented by Nordenfeldt, a Swede, was tried at Carlscrona with good results, and others since built in England have worked well. The French and the Spanish, too, have made successful experiments with this kind of boat, worked, steered, and lighted by electricity. In 1888 a submarine monitor, called the Peacemaker, was tried at New York, which stayed under water six hours at a time, the air being kept pure by compressed air.

TORTOISE. See TURTLE.

TORTOISE-SHELL, the covering or shell of a kind of sea TURTLE, found mostly in the Indian Ocean. This turtle is sometimes called the hawk's-bill turtle, because its jaws are hooked like those of a hawk; and sometimes the imbricated (Latin *imbricatus*, tiled, from *imbrex*, a tile) turtle, because its shell is formed of a series of plates like tiles, lapped one over the other as tiles are on a roof. These plates are the tortoise-shell of commerce. The finest ones, marked with the beautiful reddish brown and golden yellow shades, are those on the back; the belly plates are plain yellow.

Tortoise-shell may easily be softened by putting it into boiling water, and may then be moulded or pressed into any shape, which it will keep after cooling. Pieces may also be welded or joined together by scraping the edges down thin, warming them, and then pressing them tightly together in a screw press. When tortoise-shell is to be inlaid with mother-of-pearl, gold, silver, etc., the pieces to be inlaid are put in their proper places on the shell, which has been softened by warming, and the whole

is then screwed up in a press until the pieces are forced into the shell.

Tortoise-shell is much used for inlaying and veneering cabinets and other furniture, for making boxes, card-cases, COMBS, many kinds of ornaments, the rims of eye-glasses, etc. In making eye-glass rims only a narrow slip of shell is used for each rim. A slit is sawn in it with a fine saw, the shell is softened, and the slit is pulled open little by little until it is made into a round hole large enough for the glass. A groove is then cut around the inside of it by means of a little circular SAW, and the glass is slipped in while the shell is soft. It is lastly finished by filing and polishing. Even the filings and chippings of tortoise-shell are made use of by being softened and pressed into moulds.

Tortoise-shell is so called because it was once thought to be the shell of the tortoise.

TOUCAN, a kind of bird living in tropical America. Toucans live in flocks in forests, where they make a great chattering as they hop from branch to branch in search of food. They are handsome birds with very large bills, one kind, the toco toucan, which is seventeen inches long, having a bill half that length. They are noted, too, for their striking colors, some being bright green, with red or yellow on the breast, and some black, olive, and scarlet. Toucans nest in holes in trees, and lay two round white eggs. They post a sentinel while they feed, and his warning cry *tucano* is said to have given them their name.

The toucan belongs to the order *scansores*, or climbing BIRDS.

TOW, the coarse and broken part of FLAX and HEMP, combed out by the hackle or hatchell. Tow is not so strong as the long threads of flax and is used for cheap goods, such as sacking and common twine. It can be spun on machines nearly like those for cotton, which are easier to work than flax-machines. Tow is also much used for caulking or filling up the seams of ships to keep them from leaking, and for oiling and cleaning machinery.

The word tow is from the Anglo-Saxon *taw* or *tow*, tow.

TOYS. Until within the past few years almost all the toys used by children in this country were brought from Europe, and a great many kinds are still brought from there, but most of those that can be made by machinery or which need much skill in their manufacture are made in the United States. Tin, iron, and pewter toys, and all toys which go by clock-work and are wound up with a key are made in this country, chiefly in Connecticut, New York, and Pennsylvania. Great numbers of these metal toys are made every year, and new kinds are all the time being invented. They are sold very cheap, because most of their parts can be stamped out by machines, and all that has then to be done to them is to put the pieces together and paint them. For a long time this kind of toy was made in Germany and England, but now they cannot make them as well or as cheaply as we do.

Toy musical instruments, such as tin trumpets, jews-harps, zithers, metalophones, and drums, were once mostly made in Germany and France, but are now chiefly made in the United States, very few being brought from Europe. Almost all the drums used by American boys are made in Massachusetts. Musical boxes all come from Switzerland, and some harmonicas and jews-harps from Austria.

Almost all wooden toys come from Germany, where they are made wholly by hand, mostly by peasants in the mountains of Bavaria, Saxony, and the Tyrol. These people are very poor and do not know anything about what we call the comforts of life. They seldom get meat to eat, but live mostly on milk and vegetable food. During the summer they

work out of doors, but in winter, when the snows lie deep in their country, they employ their spare time in making toys. All the members of the family, men, women, and children, work at this business, carving poplar and plane tree wood by hand with knives and other small tools. There are made the Noah's arks, animals of all kinds, carved figures of men and women, jumping-jacks, wooden houses and furniture, villages, and all other hand-made wooden toys. As these people live so poorly and have few wants, they can make these toys much cheaper than they could be made in this country. The best carved toys come from the Tyrol, but some good ones come also from Switzerland.

Almost all dolls, with the exception of a few fine wax and porcelain ones, which are made in France, are brought from Germany. Wooden jointed dolls are made mostly in the Tyrol, wooden dolls in Saxony, and wax dolls in Bavaria. Masks, or false faces, are made mostly in Germany of PAPIER MACHÉ, in much the same way as DOLLS' heads, by moulding sheets of soft paper pulp either into moulds or over faces made of plaster of Paris. They are then dried and painted. Almost all papier maché toys, such as cats which mew, dogs which bark, and other animals, come from Germany, and they are made like the wooden toys, mostly by poor people in their own houses.

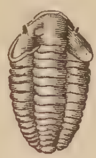
Nearly all the MARBLES, too, come from Germany, the agates from Saxony and the cheaper kinds from Bavaria. Indeed, Germany is the great toy shop of the world, for more toys are made there than in any other country; but it is probable that before many years most of those used by children in the United States, with the exception of carved wood toys, will be made in our own country.

The word toy is a short form for play-toy, meaning things or tools for play. Toy is from the Danish *toi*, tools or materials.

TRAGACANTH. See GUM.

TRIANGLE, a musical instrument made of a rod of steel, bent into the shape of a triangle, and played by being struck with a small steel bar. It is used in ORCHESTRAS and military bands.

TRILOBITE, the name given to a group of fossil CRUSTACEANS, which do not exist now. They are supposed, however, to have been somewhat like the HORSEHOE CRAB in form and in habits. They lived



Trilobite.

probably in shallow water near the coast, and fed on small aquatic animals and their spawn. Trilobites are among the oldest of the articulata (see ANIMAL). They once existed in immense numbers, and more than five hundred kinds have been found, from twenty inches in length down to very small ones.

The word trilobite is from the Greek *treis*, three, and *lobos*, lobe, so called from the three lobes of the body, the head, the thorax, and the abdomen.

TROMBONE, a wind musical instrument of the TRUMPET kind, made usually of brass, and blown by the mouth. It is made up of a long tube in two parts, one of which slides in and out of the other, and it has a broad bell-shaped end and a mouthpiece much like those of a trumpet. There are three kinds of trombones in use in military bands and orchestras, called the alto, the tenor, and the base trombones, which play different parts of the music. The tone of the trombone

is grander and more powerful than that of the trumpet.

Trombone is an Italian word, made from *tromba*, a trumpet, and means great trumpet.

TROUT, the common name of a fresh-water fish of the salmon family which includes also the SMELT and others. The common brook or speckled trout is caught in the streams of Canada, New England, and the Middle and Western States. It is eight to twenty inches long, and seldom weighs more than one and a half pounds. It is brownish above, with dark markings, yellowish-brown on the sides, and yellowish-white below, and its sides are covered with yellow spots, often dotted with vermilion. It is considered a great delicacy for the table, and anglers take much delight in catching it.

Trout are caught with the rod and line, and may be fished for in several ways, and with several kinds of bait. In fly-fishing the bait is a common fly, grasshopper, cricket, or some other live insect, or a fly made by hand. The rod should be ten or twelve feet long, and should have a reel with about fifty yards of fine silk, grass, or hair line wound on it. The line in use should be about half as long again as the rod. The fisherman must learn to throw this so that the fly will fall lightly on the water, the fly first and the line afterward. When a fish is hooked, care must be taken not to put a sudden strain on the line. If the fish jump out of water, drop the end of the pole so as to let the line loose, for if it should be tight when he comes down he will tear himself loose; but at all other times the line should be kept tight. If he runs away give him plenty of line by unwinding it, but keep it tight all the while, and when he stops wind in little by little until he is tired out, when he may be landed. Never try to lift a trout out by the line, but use a little landing net, which should be put under him. It is always best to fish down stream, when possible.

Trout may be caught also with a minnow, shiner, or shrimp. A stouter rod should be used than in fly-fishing, and the bait should be kept moving all the time. In fishing with angle-worms the line may be either cast out and drawn gently in, or, if the worm be lively, it may be held still. If the worm be dropped in carefully under banks or near rocks, fine trout may often be taken. The fisherman should be careful not to let his shadow fall on the water, and should try to keep hidden, as trout have keen eyes and are very shy, and will dart away if they see anyone. They are also frightened at any noise, and even talking will drive them away.

The word trout is from the Anglo-Saxon *truht*, trout.

TRUFFLE. See FUNGI.

TRUMPET, a wind musical instrument, made usually of brass, and blown by the mouth. As now made, it is a tube about eight feet long, but twisted round once, so as to make it only about three feet long. The end blown in has a mouthpiece, and the end from which the sound comes is bell-shaped. It has several keys by which different notes are made. Trumpets are used in military bands and orchestras.

The **Speaking Trumpet** is a straight tube with a bell-shaped end, and a broad mouthpiece into which the person using it speaks. It keeps the SOUND waves together and thus makes the voice much louder.

The **Ear Trumpet** is a kind of horn used by deaf persons. It has a small end to put to the ear, and a large end to speak into. The sound waves are thus kept from scattering and are all carried to the ear.

The word trumpet comes from the French *trompette*. The Italian name is *tromba*.

TULIP-TREE, a common North American tree, of the magnolia

family. It is found from Canada to Florida and abounds in the Middle and Western States. With the exception of the sycamore, it is the largest of our deciduous trees, often growing 140 feet high, with a diameter of eight to nine feet. It gets its name from its flowers, which resemble a large tulip, with greenish-yellow petals marked with orange. Its wood, commonly called whitewood, though it turns yellow from exposure, is soft and easily worked, and is almost as useful as the white pine. It is sometimes called also poplar, tulip-poplar, and yellow poplar, though it has no relation to the poplar tree. The Indians, who made canoes of it, called it canoe-wood.

TULLE, a fine thin silk net, used for women's veils and dresses. It is sometimes made plain and sometimes ornamented with dots. It used to be made with bobbins, but is now woven by machinery.

Tulle gets its name from the city of Tulle in France, where it was first made.

TUNGSTEN, a metal, one of the ELEMENTS. It is obtained chiefly from an ore called wolfram, in which it is found mixed with iron and manganese, and sometimes with lime. When separated, the metal is iron-gray, almost as heavy as gold, and very hard and brittle. It is used chiefly to mix with steel, especially in the manufacture of steel tubes for lining the bores of the immense rifled cannon now made. It toughens these and makes them more elastic, so that they can be fired many more times than those made of plain steel. Tungsten ore is found in Europe and in Otago, New Zealand.

The word tungsten is from the Swedish *tung*, heavy, and *sten*, stone.

TUNNEL, a passage made under ground or water for a road, canal, or sewer. It is usually very much more costly to make a tunnel underground than to make a passage way which is open to the air above; but if the ground through which the passage to be cut is very high, it may be cheaper to tunnel than to make an open roadway. This is the reason why tunnels are cut through high hills and mountains. In making a tunnel through a hill an open cut is usually made on each side through the slope of the hill until it gets to be fifty or sixty feet deep, and then the workmen begin to tunnel. They do this from both sides at once, the work being calculated so nicely that the two parts will meet in the middle of the hill; and sometimes, when a tunnel is to be very long, pits called shafts are sunk down from the top of the hill to the line of the tunnel and then workmen dig each way toward those who are tunneling from the outside.

Tunnels in rock are now usually blasted out with nitro-GLYCERINE instead of with gunpowder, which was formerly used. Holes are bored in the rock by means of DRILLS worked by machinery, and little tin tubes filled with nitro-glycerine are put into them and joined by copper wires with an electrical battery (see ELECTRICITY), a spark from which fires them all at once. The same machine which drills the holes in the rock blows air into the tunnel and clears away the smoke after each blast. At first only a small rough way, called a heading, is made, and this is afterward cut smooth and made of the right size.

When a tunnel is cut through hard solid rock it is made like an arch overhead, and it does not need any props or lining to hold up its roof; but if the rock is soft and full of seams, it has to be propped up with timber as the work goes on until walls and arches of stone are built, when the props are taken out. Tunnels in earth do not need drilling or blasting, as the earth, whether hard or sort, is easily taken out with the pickaxe and shovel, but the roof has to be carefully propped up all the time and then walled and arched with stone or brick. Tun-

nels under rivers and other water are made in the same way as those under ground, but the greatest care has to be taken that the water does not break through.

Tunnels were built in very ancient times. The Egyptians cut long tunnels through solid rock in mountain sides to make the tombs of kings and other dignitaries; and the Babylonians constructed one under the river Euphrates. The Romans made tunnels for roads, drains, or water-supply wherever they went. One of the most noted was that dug in A. D. 52 for the draining of Lake Fucinus, which took 30,000 men eleven years to complete. It was 3½ miles long and had 22 shafts, some of them 400 feet deep. This was then the longest tunnel ever made.

The longest railroad tunnel in the world is the Saint Gothard tunnel, built in 1872-81, which goes through the Alps from Italy into Switzerland. It is 9¼ miles long. The next longest one, the Mont Cenis tunnel, built in 1857–71, which goes from Italy to France, is 7½ miles long. The Arlberg, the third of the Alps tunnels, built in 1880–84, is 6⅓ miles long. The longest railroad tunnel in the United States is the Hoosac tunnel, under Hoosac Mountain, in Massachusetts, built in 1855–74, which is 4¾ miles long. One of the most difficult railway tunnels to construct was that under the Stampede pass of the Cascade range of mountains, on the Northern Pacific Railroad, built in 1886–88. The length is 710 feet short of two miles, but it is in a mountainous region covered with forests and without roads, and the work was therefore more difficult than the Alpine tunnels. The tunnel under Lake Michigan at Chicago, built to get good drinking water from the lake, is about two miles long, and a like one at Cleveland, under Lake Erie, is a mile and a quarter long. A tunnel to drain the valley of Mexico, finished in 1892, is 9⅜ miles long. The New York aqueduct, which is really a rock tunnel thirty miles long, was opened in 1890 after five years' work. There are several tunnels under the River Thames in London. One under the St. Clair river, from Port Huron, Michigan, to Sarnia, Canada, for the use of the Grand Trunk Railway, 6000 feet long, was finished in 1890. A triple tunnel for carriages and foot passengers is building under the Clyde at Glasgow, and a railway tunnel is constructing under the Hudson at New York. A tunnel under the English Channel, from Dover to Calais, to be twenty miles long, has been much talked about, and about a mile has been bored at each end; but the British Government has refused to permit the work to go on for fear of invasion from France.

The word tunnel is from the French *tonnel*, later *tonneau*, a large cask, old tunnels having been made mostly of that shape.

TUNNY, a large fish of the mackerel family, sometimes called the horse mackerel. It is common in the Mediterranean, on the coast of Europe to the Loffoden Islands, and on our North Atlantic coast to the Gulf of St. Lawrence. The tunny sometimes reaches a great size, fifteen feet long and weighing a thousand to twelve hundred pounds. Its food in our waters is chiefly MENHADEN, of which it destroys great numbers. Tunnies sometimes pursue small fishes into fishermen's nets, and do great damage. In 1878, thirty of them, weighing together about 30,000 pounds, were harpooned in a fish-pound near Gloucester, Massachusetts. The tunny has been prized for food in Europe since the times of the ancient Romans, but is seldom eaten in this country. In the Mediterranean, where it seldom weighs as much as five hundred pounds, it is caught in nets, and used both fresh and salted, and sometimes put up in oil. It is much eaten in all the Latin countries.

The word tunny, means "darter"; it is from the Latin *thunnus* or *tunnus*, Greek *thunnos*, from *thunein*, to dart.

TURBOT, a large kind of flat-fish, found in European waters. Next to the halibut, it is the largest of European flat-fishes; it sometimes weighing 30 to 40 pounds and even more. It is highly esteemed as a food fish, its flesh being white, fat, and delicate. The French call it water or sea pheasant on account of its fine flavor. Most of the turbot sold in the English markets are caught by Dutch fishermen on the sandy banks between England and Holland. The turbot has been celebrated since the days of the ancient Romans, who greatly liked it. A kind of flounder caught on our coast is sometimes called turbot in New York and New Jersey, but the true turbot is not found here.

The word turbot is Old French, from Latin *turbo*, a top.

TURKEY. The turkey was first found in America, but it is now raised in almost all parts of the world. The wild turkey was once plentiful in the United States east of the Rocky Mountains and in Mexico, but it is now much more scarce than it used to be. It is a handsomer bird than the tame turkey, its feathers being generally brown mixed with blue and green, and having a shine like copper or bronze. The head and neck are bare of feathers, the skin being bluish black with dark red lumps on it. The male bird is larger and finer looking than the female.

Wild turkeys live in flocks in the woods, where they feed on acorns, nuts, berries, buds, and insects. They also like wheat, corn, and other grains, and often do great damage to fields. Their wings are strong and they can take long flights, but as they can run very fast they seldom fly unless forced to do so. At night, however, they fly up and roost on the tops of the highest trees. When the female turkey gets ready to lay her eggs she steals away to some quiet spot, because the male turkey will break them if he finds them. She makes her nest in a hollow in the ground, lining it with soft grass, moss, and leaves, and lays ten or fifteen yellowish-white eggs, speckled with brown. When she leaves her nest to get food, she carefully covers it over with reeds and grass to hide it from the eyes of the fox, lynx, and crow, all of whom like turkey eggs. After the young are hatched, the mother leads them away into quiet and hidden places, and cares for them for several months, until they are old enough to go alone.

Hunters usually shoot turkeys on their roosts by night, especially on slightly misty moonlight nights, when these birds are not so much on their guard as in clear weather. Many are caught also in traps by day. A turkey trap is a pen made of fence rails and covered over at the top, and has a trench leading under one side of it. Corn or some other grain is scattered along the trench and a quantity is put inside the pen, and the turkeys, walking along with their heads down to pick it up, soon find themselves inside. The foolish birds could walk out easily enough in the same way they came in if they would only put their heads down again, but as there is no corn to show them the way, they stretch their heads up high and run round looking for a hole to get out of. The Indians catch many of them and use their feathers for making ornamental work.

The **Tame Turkey** is descended from the wild turkey. Though its feathers are duller than those of the wild turkey, it is generally much larger. Its flesh is liked by most people better than that of any other domestic fowls, but the flesh of the wild turkey is sweeter and more juicy than that of the tame turkey. The turkey is the principal meat of our Thanksgiving and Christmas dinners. Turkeys were first carried

to England in the early part of the sixteenth century. The first turkeys raised in France were eaten at the wedding of Charles IX. in 1570.

The turkey belongs to the order *rasores*, or scratching BIRDS, and to the pheasant family.

The turkey is short for Turkey cock or Turkey hen, it being so called because it was once believed that it came from Turkey, meaning Tartary or Asia. It was supposed to come also from India, whence the French name *dinde*, which is short for *poule d'Inde*, cock or hen of India. The Spaniards also call it *gallina de India*, and the Germans *Indianische henn*, Indian hen.

TURMERIC, the roots of an East Indian plant, belonging to the same family with ginger. The roots are orange-yellow inside, smell somewhat like ginger, and have a spicy taste. The East Indians use it to season curry, and it is used also to give a yellow color to varnishes, and to color ointments. Though its color is not very lasting it is much used in dyeing silks and woollens. The turmeric sold in the stores is usually in the form of a yellow powder, made by grinding the roots.

The word turmeric is said by some to be from the New Latin *terra merita*, valuable earth.

TURNIP, a garden or field plant cultivated for its bulbous root, which is used for food. It grew first in the mild parts of Europe, and in Siberia, where it grows wild. There are several kinds of turnips, belonging to two different varieties: common turnips, with the bulb usually broader than long, and Swedish turnips or ruta-bagas (Swedish *rotabaggar*, root rams), of which the bulbs are longer, larger, and more solid. In Great Britain the turnip crop is very important, as farmers depend on it for winter food for cattle and sheep; but in this country, where Indian corn abounds, turnips are not much raised excepting for table use. They are not worth much for food, as they are more than nine-tenths water. The Hebrews did not know the turnip, but the Greeks and Romans cultivated it.

The word turnip is in Old English *turnep*, and is from the Welsh *turn*, round, and the Anglo-Saxon *næp*, turnip.

TURPENTINE, the sap of the pine, fir, and some other cone-bearing trees. American turpentine is got mostly from the long-leaved pine, which grows in Georgia, North Carolina, and Florida. A cut is made through the bark of the tree, and the sap flows outand is caught in pails or jars set to catch it. This, which is called crude turpentine, looks much like honey. Spirits or oil of turpentine is made from crude turpentine by distillation (see ALCOHOL), the solid part which is left being the common yellow resin used in making soap, candles, varnish, fireworks, for caulking the seams of ships, and for putting on violin bows. Oil of turpentine is used in medicine, in making varnishes, and for mixing with paints. When distilled a second time and purified it becomes camphine, once much used to burn in lamps.

Canada Turpentine, called also Canada balsam, is got from the balm of Gilead, a kind of FIR tree. Venice turpentine is the sap of the larch tree, and Strasburg turpentine the sap of the silver fir tree. Another kind of turpentine is made in Syria and some of the Greek Islands, from the same tree on which the pistachio nut grows.

The word turpentine is from the Latin *terebinthus*, Greek *terebinthos*, the turpentine tree.

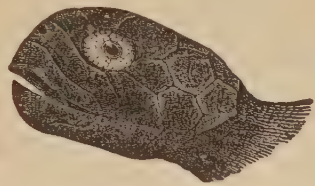
TURQUOISE, a mineral of a beautiful sky-blue color, much prized for ornaments. It is found chiefly in the mountains of Khorasan, in Persia. It is said that the Shah keeps all the best turquoises for himself, and will let only the poor ones be taken away. In the East turquoises are used to ornament fine bridles,

saddles, girdles, swords, and other things. In Europe and this country they are set in jewelry with pearls and diamonds. The turquoise is sometimes given as a pledge of love, in the belief that its color will fade if the giver be unfaithful; but in reality the color will often change in damp air. Turquoise is now mined near Los Cerillos, New Mexico. The Aztecs worked it before the Spaniards came, and the Pueblo Indians use it for ornament and for money, buying with it ponies, blankets, baskets, etc., from the Apaches, Zunis, and other tribes.

The turquoise is so called because it was first brought from Turkey, meaning Asia.

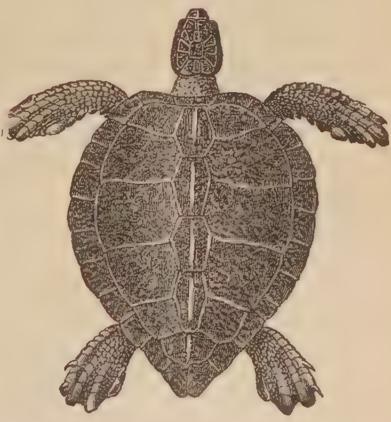
TURTLE and **TORTOISE.** Turtles live in the sea, while tortoises live mostly on land, but sometimes in marshes and rivers. The skeleton of turtles and tortoises is mostly on the outside, and forms a kind of bony house into which they can draw themselves when attacked. In some of the tortoises this bony covering is so jointed that they can shut it up close after drawing in their heads, legs, and tails. The under part, which takes the place of the breast bone in other animals, is usually made up of one piece, but the upper is made up of many plates of bone, nicely fitted together and overlapping each other. The inside part of the skeleton of a turtle can be seen in the picture on page 621.

Sea turtles swim very easily, and they can stay a long time under water. The opening to the nose is covered by a lump of flesh which acts like a VALVE, opening when they breathe the air, but closing tight when they go under water. They have no teeth, but their jaws are edged with a hard and sharp kind of horn, like the beaks of birds of prey. The tough stems of sea-weeds, on which they feed, are more easily cut by these scissors-like jaws, the shape of which can be seen in the picture, than they could be by teeth. CRUSTACEANS, too, and even MOLLUSKS are crushed by them.



Head of Turtle.

The **Loggerhead Turtle** is one of the most common kind, being found along the Atlantic coast from Virginia to Brazil, on the Atlantic coasts of Europe, and in the Mediterranean. It is also one of the largest of the turtles, being generally about four feet long, and has a smooth shell, as shown in the picture. This turtle feeds mostly on mollusks, the shells of which it crushes in its strong jaws. The flesh of the young is sometimes eaten, but that of old ones is valuable only for the oil which is boiled out of it and which is good for burning in lamps.



Loggerhead Turtle.

The **Green Turtle,** which is named from its green fat, from which turtle soup is made, is found chiefly in

the West Indies, whence great numbers are sent alive to this country and to Europe. These turtles come ashore in warm weather to lay their eggs in holes which they dig in the sand, and are then easily caught, either with HARPOONS or by turning them over on their backs, for when turned over they cannot get back again. They often go hundreds of miles out to sea, and are sometimes caught sleeping on the top of the water. In the Pacific islands they are chased by the natives in canoes. When the canoe comes up with a turtle it dives, but the water is so clear that it can still be seen and followed, and when it comes up again a man in the bow jumps on to its back and clings to its shell until it is tired out, when it is easily taken. The Chinese have a still more curious way of catching turtles. They have a kind of fish called the sucking-fish, which they put into the water with a string tied to its tail. The fish darts at the turtle and holds fast to it with its sucking mouth, and both fish and turtle are then drawn into the boat. The green turtle sometimes grows as long as a man and weighs five hundred or six hundred pounds.

The **Hawk's-Bill Turtle,** so called because its upper jaw is hooked like the beak of a hawk, is found in the West Indies and other warm part of America, and in the Pacific and Indian Oceans. It is seldom more than three feet long; its flesh is not very good to eat, and it is sought after only on account of its beautiful horny plates, the TORTOISE-SHELL of trade. These are yellow above, marked with rich brown and reddish tints, and yellowish white below. The best tortoise-shell is brought from Singapore and Canton.

Tortoises. There are several kinds of tortoises in the United States, most of which are small; but the snapping turtle, found from Maine to Georgia, is sometimes four feet long. It is so called because it snaps fiercely at any thing within its reach, and when it bites a thing it is very hard to make it let go. It feeds mostly on fish, reptiles, and water fowl. Other kinds in the United States are the spotted tortoise, the box tortoise, the gopher tortoise, the soft-shell tortoise, the mud tortoise, and the TERRAPIN. The terrapin, of which there are several kinds, is much esteemed for food.

Turtles and tortoises form one of the orders in the class REPTILES. The order is called also *chelonia*, from the Greek *chelone*, tortoise.

The word turtle, formerly also tortle, is probably a corrupt form of tortoise, which is said to be from the Spanish *tortuga*, tortoise, from Latin *tortus*, twisted, so called on account of its crooked feet.

TURTLE-DOVE, the common name of several small pigeons, found in various parts of Europe, Asia, and Africa. The common European turtle-dove, which goes southward at the end of summer and returns in May, is brownish-gray above and white below. It is seen generally in flocks of twenty or more in woods, making itself known by its pleasant cooing.

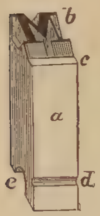
The **Carolina Turtle-Dove,** sometimes called mourning dove, is found all over the United States from the Atlantic to the Pacific, and also in Cuba. It is bluish above, purplish on the breast, and light brownish-red below. Great numbers are killed in the Southern States in winter.

The turtle-dove belongs to the order *rasores*, or scratching birds.

The word turtle, in turtle-dove, is Anglo-Saxon, and is from the Latin *turtur*, dove, probably so called in imitation of its cooing.

TYPE, a letter for printing. The form of a type is shown in the picture; the part marked *a* is called the body, *b* the face, *c* the shoulder, *d* the nick, and *e* the groove. The face is the part with which the printing is done. The nick, which is always on the lower side of a type, is to help the

compositor (see PRINTING) in picking it up. The compositor feels the nick with his finger as he sets the type up in his stick, and thus knows that all the letters are right side up. Some type have two, three, or four nicks, which serve to mark different founts or sets, all of one kind being marked in the same way. The groove in the bottom of a type is to make it stand up steadily on the imposing table. If the type were flat on the bottom a little dust on the table would make it stand uneven.



Type.

A full set of types of one kind, enough for printing, is called a fount or font. A fount of type does not have the same number of each letter of the alphabet, for many more of some letters are used than of others. If it has one of the letter *z*, it will have sixty of *e*, forty-five of *t*, and forty each of *a*, *i*, *n*, *o*, and *s*. You will see from this that the letter *e* is used more often in printing than any other letter. The types in an ordinary book fount are

CAPITALS.
SMALL CAPITALS,
lower-case or small letters,
ITALIC CAPITALS,
and lower-case italics,

and figures and punctuation marks; in all about two hundred different characters. Printers have a different name for each size of type.

The principal sizes used in book printing are:

Nonpareil—abcdefghijklmnopqrstuvwxyz.

Minion—abcdefghijklmnopqrstuvwxyz.

Brevier — abcdefghijklmnopqrstuvwxyz.

Bourgeois—abcdefghijklmnopqrstuvwxyz.

Long Primer—abcdefghijklmnopqrstuvwxyz.

Small Pica—abcdefghijklmnopqrstuvwxyz.

Pica—abcdefghijklmnopqrstuvwxyz.

English—abcdefghijklmnopqrstuvwxyz.

The type of this cyclopædia is bourgeois.

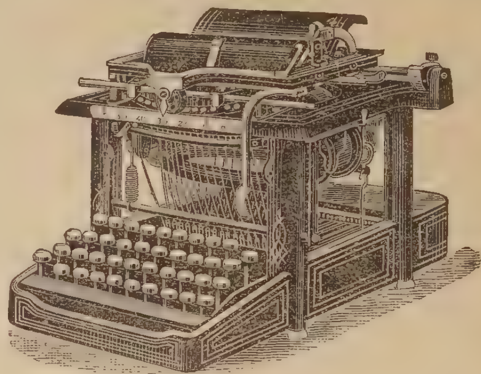
Type Making. Most types are cast in metal, but some for printing large letters on show bills and other coarse work are cut out of wood. In old times printers used to cast their own types, but now they are made by men called type-founders, who make a business of it. The first step is to cut a punch or die, one of which has to be made for every letter. The letter is cut by a die-cutter (see DIE), exactly like the letter on a type, on the end of a little bar of soft steel. The steel is then hardened and the dye is ready for use. The workman now takes a little piece of copper, and setting the letter end of the die on it, strikes the other end with a hammer until the letter on the die is pressed into the copper so as to make an exact impression of it. The piece of copper is then carefully cut down until it is exactly the width of the type to be cast and will fit into the end of the mould. This little piece of copper is called a *matrix*. The mould is a small frame or box, made in two parts so that it will open on a hinge. When it is shut up the inside, which is made of steel, forms a little box exactly the size of the type to be cast. If you look at a lot of types together, you will see that some of them are wider than others: the letter *l*, for instance is very narrow, while *m* and *w* are four or five times as wide; but all the types are of exactly the same height. Now, as only one mould is used in casting all the letters in one alphabet, it is so made that it can be set wide or narrow, so as to fit any type or matrix. The matrix is fitted at one end of

the mould so that the letter on it will come right in the middle of the little box. At the other end of the mould is a place to pour in the melted metal.

Type metal is an ALLOY made up of lead, antimony, tin, and sometimes a little copper. More lead is used than anything else; the antimony hardens it, and the tin and copper make it tough. When it is poured into the mould it fills up the letter in the matrix and the little box which makes the body of the type, and cools at once. The workman then opens the mould, throws out the type, and closes it ready to be filled up again. This was once always done by hand, but types are now cast by machines which do it much quicker. When the types come from the mould they have rough edges and there is a little piece of metal hanging to the bottom where the lead was poured in. This little piece is broken off by a boy, and the types are then sent to another boy who rubs them on a stone and makes them smooth. They are next examined to see if the edges are exactly square, and the groove is cut in the bottom of each. They are then put up in papers, each letter by itself, when they are ready for sale.

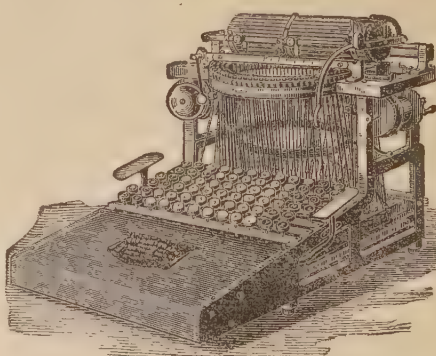
The word type is from the Latin *typus*, Greek *tupos*, a stamp.

TYPEWRITER. Like the sewing machine, the typewriter, in its perfected form, is an American invention. A kind of typewriter was made in England as early as 1714 by a man named Mill, but though he was given a patent for it, it never came into use. In 1833 a Frenchman, Xavier Progrin of Marseilles, was given a patent for an instrument



Remington Typewriter, No. 2.

called by him a "ktypographic machine," because it printed by striking (Greek *ktupos*, a sound made by striking, and *graphein*, to write). He claimed that it would print almost as rapidly as one could write with a pen, and said: "It will give birth to a new art—that of ktypography." Although



The Caligraph.

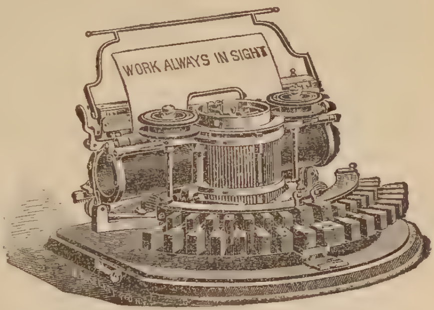
his machine did not succeed, it was made on a principle which has since developed into the modern typewriter —a series of letter levers so arranged

in a circle so as to make impressions on a common center.

The first American patent for a typewriter was given in 1843 to Charles Thurber of Worcester, Massachusetts. Thurber was followed by S. W. Francis and by Thomas Hall; and about the same time (1868) Charles Latham Sholes of Milwaukee, Wisconsin, who had been experimenting with others, made what is now called the Remington No. 1. In 1877 the double alphabet machine, called Remington No. 2, was first made, and this is still one of the best machines in use. With it a skilled operator can print more than ninety words a minute. The Caligraph, the invention of George W. N. Yost, will print about as fast as the Remington. Among other typewriters are the Crandall, by L. G. Crandall; the Hammond, by James B. Hammond; the Century, by Thomas Hall; the Yost, by the maker of the Caligraph; and many small machines, among them the Columbia, Crown, World, Sun, Anderson, Capitol, Barlock, Morris, and Herrington, the last a pocket machine, weighing only half a pound.

Almost any kind of paper can be used on the typewriter, but generally thin unruled paper $8\frac{1}{2}$ inches in width is preferred. The inks are made of glycerine with aniline colors, and may be had in all colors. Purple ink is sometimes used, but black is generally preferred. By the use of carbon paper several copies may be made at once.

The typewriter is one of the most important inventions of the century. It has made a great change in business methods, almost all correspondence being now carried on by its means. This has made business easier and has given pleasant and profitable employment to thousands of persons, especially young women. Authors' manuscripts are now generally type-written before going to the printers, thus preventing many errors which are sure to creep in when type is set from the original writing. Writers, too, afflicted with scrivener's palsy use the typewriter with ease, and thus save both hand and eyes.



Hammond Typewriter.

U

UMBRELLA. Although umbrellas have been in use in Asia from the oldest times, they were not generally carried by men in Europe and in this country until about a hundred years ago. The first umbrella ever used in the streets of London was carried, about 1750, by Mr. Jonas Hanway, who had seen them in China and other parts of the East. It is said that when he first walked the streets with one on a rainy day he was hooted and hissed by men and boys, and even pelted with stones. Before that time an umbrella was usually kept in the halls of houses of the rich, and was held by a servant over the heads of people as they passed to and from their carriages on rainy days; but the man who was afraid of a wetting was thought to be very weak. In an old English dictionary (Kersey, 1708) an umbrella is defined to be a "screen commonly used by women to keep off rain."

Chinese and Japanese umbrellas are much like ours, but the frames are generally of bamboo and have many more ribs than ours. The best ones are covered with silk, but most of them are made of paper, prettily painted and glazed, and made water-proof. In China people of different rank are sometimes known by the number of their umbrellas. Thus the emperor has twenty-four carried before him, the heir to the crown ten, and other princes and nobles five, three, two, etc., according to their rank.

One of the titles of the King of Siam is "supreme owner of the umbrella." This does not mean a common umbrella, but the umbrella of state, which is made of crimson or purple silk richly set with precious stones, trimmed with gold fringe, and lined with white satin wrought with silver flowers and seed pearls. An umbrella like this is carried over the king's head wherever he goes, and any other person using one like it in that country would be punished with death. On very great occasions umbrellas several stories high, placed one above the other, so as to make a pyramid, and with all their edges hung with little bells, are used. In Burmah the king's umbrella is white and those of the nobles of the court red for use in the royal city, but in other places they have gilded ones.

Great numbers of fine umbrellas and parasols are made in this country. Common umbrella sticks are made of maple wood, turned round on a lathe, and bent at the end. The best sticks are of bamboo, orange, myrtle, dogwood, and pimento; and some have handles fitted of ivory, horn, silver, tortoise-shell, and other materials. The ribs are now mostly made of steel, though bamboo and whalebone are used in some cheap umbrellas. The best umbrellas are covered with silk; cheaper ones with alpaca, cotton, and thin indiarubber cloth. Umbrella silk is brought chiefly from Lyons, France, and Crefeld, Germany.

The word umbrella is made from the Latin word *umbra*, a shade. The word parasol is made up of the French word *parer*, to ward off, and the Latin word *sol*, the sun.

UNIVERSE. When we look up into the sky at night the stars ap-

pear to be scattered over a great vault, and one does not look any further away than another. The moon, too, looks larger than the stars, though it is really much smaller. It looks larger only because it is nearer to us, many of the stars being so far away that our minds are not able to even think of the distance. There is reason to believe that some of the nearest of the stars are several hundred times larger than the sun. Indeed, all these distant stars, which are so far away that they look like little specks in the sky, are really great suns like ours, and each is the centre of a group of bodies like the earth, which turn around it just as the earth turns round the sun. The bodies which revolve round these far-away suns are so small that we cannot see them, but it is believed that they are there and that each one of them gets light and heat from its sun just as we do from ours.

Solar System. Thus we see that the universe is formed of many worlds or groups of bodies, each made up of a sun with other bodies turning round it. Each of these groups is called a system (Greek *systema*, a group of many things). The group to which the earth belongs is called the solar system, because the sun (Latin *sol*) is the centre of it. It is made up of the sun and of eight bodies called planets (Greek *planetes*, wandering), because they appear to wander among the stars. The earth, which is one of the eight, is also called a planet because, though we cannot see it, it would appear to an astronomer on any of the other planets to wander just as the others appear to us.

The planets turn round the sun at different distances from it. The one nearest to the sun is Mercury, and after it come in order Venus, the earth, Mars, Jupiter, Saturn, Uranus, and Neptune. All of these, excepting the earth, are named after the gods of ancient Rome. Mercury, Venus, and Mars are smaller than the earth; all the others are much larger. Several of these planets have smaller bodies called satellites (Latin *satelles*, an attendant) which turn round them. Our moon is the satellite of the earth. Mercury and Venus have no satellites, but Mars has two moons; Jupiter five moons; Saturn eight large moons besides three great rings supposed to be made up of many small satellites; Uranus four moons, and Neptune one moon. Besides the planets there are many smaller bodies called asteroids (Greek *aster*, star, and *eidos*, form), because they are like stars in form, which move round the sun between Mars and Jupiter. They can be seen only through a TELESCOPE. These are all the real members of the solar system, but there are some other moving bodies, such as comets and meteors or falling stars, which may be looked upon as visitors, as they come only now and then. Comets usually come from outside the solar system, pass round the sun and then go back again. There are many of them, but most of them are too small to be seen with the naked eye. Those which we see have bright heads and long fiery tails, but we do not know much about them. Meteors or falling stars have sometimes fallen to the earth, so that we have been able to see what they are made of. Some of them are like our metals and some are stony (see AËROLITE). Some think that comets are partly made up of the same kind of matter as meteors, which are now known also to go round the sun. In ancient times comets were looked on with great awe, and were thought to bring all kinds of troubles, and even in these days some people are frightened by them.

The picture gives a view of the solar system as it would look if seen from above, but the sizes of the different bodies and their distances from each other cannot be given in

so small a space. The sun is more than seven hundred times larger than all the planets put together. If a globe a little more than two feet across stood for the sun, the proper size of Mercury would be shown by a grain of mustard seed, of Venus by a pea, of the earth by a little larger pea, of Mars by a large pin's head, of the asteroids by grains of fine sand, of Jupiter by an orange, of Saturn by a smaller orange, of Uranus by a full-sized cherry, and of Neptune by a good-sized plum. It would be much harder to tell about the distance from the sun of the different planets, because even the nearest one is so far off that the mind can scarcely take it in. The distance from the earth to the sun is so great (92,000,000 miles) that if there were a railway between them, a train, going a mile a minute, or sixty miles an hour, would require 175 years to get to the sun. If a cannon ball shot from a gun should

The Solar System.

keep on going at the same speed it had when it left the gun it would take it nine years to reach the sun; and if a boy could walk four miles an hour and keep it up for ten hours every day, it would take him more than six thousand, three hundred years to get to the sun. Neptune, the planet most distant from the sun, is more than thirty times further from it than the earth is. Only a faint idea can be got from this of the great size of the solar system. But when we think that the solar system is only a very small part of the universe, and that there are many million other such systems beyond ours, we are lost in wonder and admiration.

All the planets and their moons are, like the earth, cool bodies, and therefore give out no light of their own. They look light to us because they reflect the LIGHT of the

sun. Venus is the brightest of them all, and Jupiter is the next brightest. Mars looks reddish to the naked eye, but is bright when seen through a telescope. Mercury, Venus, Mars, Jupiter, and Saturn can be seen with the naked eye at the right seasons, but the others can be seen only through a telescope.

Motions of Heavenly Bodies. In the article EARTH (ATTRACTION OF GRAVITATION) is explained that what we commonly call weight is really a kind of attraction or force by which the earth draws everything near it to itself; and that it is this force that keeps everything on the earth as it rolls round in the heavens. It is also explained that everything on the earth has an attraction for every other thing, and that the larger a thing is the greater is its power to draw other things to it. The earth, therefore, being so much larger than anything on it, attracts all others things with so much greater force that their attraction is not felt by us. This rule holds good, not only for all things on the earth, but also for every thing in the heavens: every thing or body is attracting toward itself all other things or bodies, and the larger the thing is the greater is the strength of its attraction.

All the planets then in the solar system attract each other; but the sun, which is about seven hundred times larger than all of them put together, attracts them so much more strongly, that everything in the solar system is drawn with great force toward the sun, and if they were not kept in their places by another force, they would all be drawn into the sun. When we swing a sling with a stone in it about our head the stone goes round in a circle, of which the hand holding the sling is the centre. The stone seems to pull on the string, and if we let go of the string it flies away quickly. The force with which the stone pulls and tries to get away is called centrifugal (centre-flying, Latin *centrum*, centre, and *fugere*, to fly) force—that is, the force with which everything tries to fly off the centre; and it is the string which keeps it from thus flying off.

The earth and the other planets turn round the sun just as the stone goes round our hand when we swing the sling, and like the stone they are all the time trying to get away; but they are all held in their orbits by the attraction of the sun, which keeps them from flying off just as the string keeps the stone from flying off. These two forces, then, gravitation and centrifugal force, by acting together keep the planets in their orbits; if there were no gravitation, they would fly away into space, and if there were no centrifugal force, they would fall into the sun. By the action of the same two forces the moon is made to turn round the earth, and all the other heavenly bodies are kept in their places and given their proper motions.

The path of a planet or other body through the heavens is called an orbit (Latin *orbita*, a track, from *orbis*, a circle). The orbits of the planets and of a comet round the sun, and of the moon round the earth, are shown in the picture. The time taken by a planet in going round its orbit makes its year, and this is different in each one. Mercury goes round the sun once in eighty-eight days, so its year is less than a quarter as long as ours. Venus takes two hundred and twenty-four days to go round, the earth just a year ($365\frac{1}{4}$ days), Mars nearly two years (687 days), Jupiter about twelve years (4333 days), Saturn nearly thirty years (10,759 days), Uranus about eighty-four years (30,686 days), and Neptune more than one hundred and sixty-four years (60,126 days).

But besides this motion round the sun the planets have another motion: each one spins round like a top, both motions going on at the same time. The time taken by each planet in turning round once makes its day,

which is of a different length in each. The earth turns round once in twenty-four hours, Mars once in twenty-four and a half hours, Jupiter in about ten hours, and Saturn in about ten and a quarter hours. We do not know exactly how long it takes the others to spin round.

The word universe is from the Latin *universum*, all things, the whole world.

URANIUM, a metal, one of the ELEMENTS. It is very rare and valuable, its cost being (1893) about $10 a pound. It is used in the manufacture of stained glass to make a greenish-yellow tint, for coloring black porcelain, and like nickel, for hardening steel for making cannon, armor plates, etc. Uranium mining is carried on at only two places in the world, at Annaberg, Saxony, and at Redruth, Cornwall, England; but the metal has been found in the Black Hills, Dakota, and it is thought that it may be produced as cheaply as aluminum. It was discovered in 1789 by Klaproth, a German chemist, who named it in honor of Sir William Herschel, the discoverer of the planet Uranus.

URANUS, one of the planets of the solar system (see UNIVERSE). Excepting Neptune, it is the outermost one of the planets, it being more than nineteen times as far from the sun as the earth, too far for us to know much about it. When seen through a telescope, it has a greenish or bluish disk with two bands. Its diameter is about 31,000 miles, and it is therefore about 74 times as large as the earth. It goes round the sun once in eighty-four years and a week. Uranus was discovered to be a planet by Sir William Herschel in 1781; it had been seen before, but had been taken for a star. It has four satellites or moons.

Uranus was named after the Greek god *Ouranos*, the personification of the sky or heavens.

V

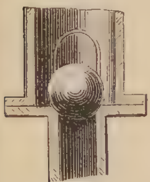
VALVE, a cover to a tube or a hole in a vessel, which will open and let water or any other fluid pass in one way, but stops it from going the other way. The pressure of the fluid opens the valve and closes it. Three kinds of valves are shown in the

Flap Valve.

pictures, the flap-valve, which opens and shuts like a door; the puppet-valve, which is moved up and down

Puppet Valve.

by a rod fastened to it; and the ball-valve, which is opened and shut by a ball which moves up and down. The flap-valve is the kind used in PUMPS. The puppet-valve is much used in steam engines. The safety-valve on steam boilers works on this principle, but has a certain weight put on it so that it



Ball Valve.

will rise up only when the steam makes a pressure greater than the weight. Thus, when there is too much steam in the boiler, the valve will be forced open and the boiler thus saved from bursting. Another kind of valve used in steam engines is called a slide-valve; it is a cup-shaped piece of metal which is slid on and off so as to cover and uncover a hole to let steam pass and repass to the engine. The ball-valve is used in different kinds of machines.

The word valve is from the Latin *valvæ*, folding doors.

VANILLA, the common name of the fruit of a Mexican plant, much used for flavoring. The plant is a climbing plant of the orchid species, some like the ivy, which grows on trees but lives on air. It bears greenish-yellow flowers, which are followed by a slender pod, about eight inches long. The pods are picked before they are quite ripe, because when fully ripe they split in two. They are pulpy inside and are filled with small black oily seeds. When dried in the sun the pods grow brown and wrinkled, and shrink into one-fourth of their former size. They are packed for market in bundles of fifty to a hundred, and covered with tin-FOIL or put into metal boxes.

Vanilla comes mostly from Mexico, but is raised also in Central and South America and the West Indies. Much of that used in France is brought from Guadeloupe, Madagascar, the Island of Reunion, and Tahiti. It was used by the Mexicans for flavoring chocolate long before the Spaniards came to America. It is still used for the same purpose, the little seeds being ground up with the chocolate. It is also largely used in making confectionery, pastry, ices, liquors, cordials, and perfumery. Ice cream, confectionery, cake, etc., are flavored with the extract of vanilla, made by cutting the pods into small pieces, grinding them up with sugar, and then mixing the paste with weak alcohol.

Vanilla is now made also from the wood of the pine tree.

The word vanilla is Spanish and means a little sheath, and the vanilla is so called because its pods look like a little knife sheath.

VARNISH, a kind of paint made out of resins or gum resins, mixed with spirit or some other liquid, used on things to make them shine or to protect them against air or dampness. The chief RESINS used are copal, mastic, lac, benzoin, resin, amber, asphalt, and caoutchouc; and the chief liquids with which they are mixed are alcohol, turpentine, ether, and olive, linseed, and poppy oils. Some kind of coloring matter is also usually put in. Varnishes are made by boiling together the things of which they are composed, and frequently stirring and straining. As the resins, oils, etc., are liable to take fire, it is a very dangerous business. Varnishes are used on many kinds of metals, on plain and painted woods, on leather, and many other things.

The word varnish is in Old English *vernish*, which is probably from a Latin word meaning to glaze.

VELOCIPEDE. The first velocipede was made in 1817 by Karl von Drais of Mannheim, Germany, and was called after him a "draisine." It was made some like the present two-wheeled velocipede, but the rider had to make it go by pushing with his feet on the ground. A picture of it is given in the article CYCLE. This kind did not come much into use; but about 1867 velocipedes began to be made with a crank or kind of handle on each side of the fore wheel to be turned by the feet, like those now in use. Velocipedes are made with two, three, or four wheels. Three and four-wheeled ones are mostly used by young children, as two-wheeled ones are much harder to ride. The two-wheeled velocipede has one large wheel, and a second small wheel which runs behind, the rider's seat being above between the two.

The word velocipede is from the Latin *velox*, swift, and *pedes*, feet.

VELVET, a kind of cloth woven of silk or of silk and cotton mixed, and having a soft pile or nap. Velvet made of all cotton is called velveteen. A kind of stuff like velvet, made of worsted and goats' hair, is called plush. In weaving velvet a third set of threads, besides the warp and woof threads, are woven over brass wires laid crosswise, thus making little rows of loops. Each wire has a little groove or slit along its top, and along this is run a sharp-edged knife, thus cutting all the loops so that they will stand up. These are afterward brushed up and sheared smooth to make the nap. In fine velvets there are fifty or sixty rows of loops in every inch, so that weaving them is very slow work. Striped and plaided velvets are made by cutting some of the loops and leaving others uncut; and some velvet is left altogether uncut, the wires being drawn out so as to leave the loops standing.

The word velvet is from the Latin *vellus*, a fleece, which is soft like velvet.

VENEER, a thin layer of wood glued upon a cheaper kind of wood to give it a finish. As veneers are made of handsome and costly kinds of wood, such as rosewood, ebony, mahogany, etc., they are usually cut very thin, to make them go as far as possible. They used to be cut by hand, but they could not be made very thin or very even in that way, and they are now sawn from solid blocks or logs of wood by circular saws turned by machinery. By this means veneers are cut very wide and as thin as cardboard. When the cabinet maker uses veneers he roughens one side to make it stick better, and then glues it on the board to be covered, and clamps it tight until it is fully dry. The other side is then smoothed with planes

and scrapers, and polished with sand-paper and PUMICE, when it may be finished by varnishing, or oiling.

Veneers are sometimes made of ivory, malachite, and other things. A pianoforte was veneered in Paris with ivory cut from a single elephant's tusk, and in Russia tables and other furniture are sometimes covered with veneers of malachite sawn very thin and fitted together so that all the veins of the stone are made to match. When veneers of different colors are fitted together in patterns so as to make a kind of inlay work, it is called buhl-work, from a French cabinet-maker named Buhl, who lived in the time of Louis XIV. Buhl-work is also made sometimes with thin brass and tortoise-shell.

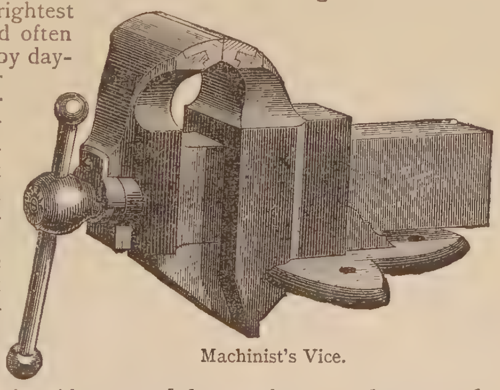
The word veneer was formerly fineer, corrupted from furneer, from German *furniren*, to veneer, which is from the French *fournir*, to furnish.

VENUS, one of the planets of the solar system (see UNIVERSE). Like MERCURY, it is an inferior plant, being the second from the sun and next within the earth's orbit; but is much easier seen, it being, next after the sun and moon, the brightest object in the heavens, and often visible to the naked eye by daylight. As it comes nearer the earth than any other plant, it has been carefully studied ever since the telescope was invented, but very little has been found out about it. Most astronomers think it has an atmosphere nearly twice as dense as our own; but we do not know the exact time of its revolution on its axis, nor do we know anything about its surface. In old books it is said to revolve on its axis once in about 24 hours or the same as the earth, but it is now thought that it turns but once in about 225 days, which would make its night and day very long. Venus is nearly as large as the earth, its diameter being about 7660 miles. It goes round the sun once in a little more than 224 days. No satellite or moon has ever been seen.

Venus, one of the planets known to the ancients, was named from the goddess Venus.

VERDIGRIS, the common name of a green substance (copper acetate) which collects on copper. The verdigris of commerce is made by piling up plates of copper with layers of grape skins between them. In a few weeks a green crust forms on the copper; this is scraped off, made into a paste with vinegar, and pressed into moulds. It is also made sometimes by putting plates of copper in cloths dipped in vinegar. It often forms in copper kettles in which anything sour is cooked, and as it is a rank poison, great care should be taken in cleaning such vessels. It would be still better to have all such vessels tinned. Verdigris is used for making green paint, for dyeing black with logwood, for giving a beautiful green to porcelain, and other purposes.

The word verdigris is in French *verd-de-gris*, from *verd*, green, *de*, of, and *gris*, gray, which is from the Latin *viridis æris*, green of brass.



Machinist's Vice.

VICE, an instrument used by mechanics to hold work in for filing, cutting, etc. It is made up of two

jaws, in which the work is put, and a screw moved by a handle by which they are screwed up tight together. The vice shown in the picture is a kind used by machinists. When the handle is turned the front jaw moves forward or backward straight out from the back one, so that it can be made to hold large pieces of work. In the blacksmith's vice the front jaw reaches down much further and is loosely fastened at the bottom. It cannot be opened quite so far as the machinist's vice. Carpenters use wooden vices, made much like a blacksmith's vice, to hold boards and other pieces of wood for cutting, planing, etc. Jewelers have very small vices made to be held in the hand, to hold small pieces of jewelry on which they are working.

The word vice, or vise as it is sometimes spelled, is from the French *vis*, a screw.

VINEGAR, weak acetic ACID, used for flavoring food, and for preserving pickles and other things. In the United States vinegar is made mostly out of cider. The cider is left in a warm place in barrels with their bung-holes open, so that the air can get at it. The OXYGEN of the air changes the ALCOHOL in the cider into acetic acid; but as there is not much alcohol in cider there is made only a little acetic acid, and this, mixed with the water of the cider and some coloring matter and other impurities from the juice of the apples, makes up the vinegar. In England much vinegar is made from malt and from soured beer and ale. In France it is made mostly from wine; red vinegar being made from red wine and white vinegar from white wine.

The word vinegar is from the French *vinaigre*, sour wine, from *vin*, wine, and *aigre*, sour.

VIOLIN, a stringed musical instrument, played with a bow. A violin looks to be a simple enough thing to make; for it is made up of only a hollow body of wood, a solid wooden neck, some strings with pegs to screw them up with, and a small piece of wood called a bridge to lift the strings up from the body. All these things are easily shaped and easily put together, but while one violin may be a very fine one, another made just like it may be of little or no value. The reason of this depends on a great many things, such as the fineness and thinness of the wood, the size and form of the sound holes cut in the top, the strings, etc. The body of the violin is made up of a sounding board, always made of straight-grained deal, and a back, made usually of maple, but sometimes of sycamore or pear wood. The sounding board and the back are very thin, and are arched so as to bear the great strain of the strings when they are screwed up tight. Upon the neck is a finger-board made of ebony, and the bridge, over which the strings are stretched, is made of beech wood. There are four strings, three of which are made of catgut, and one of which is wound round with wire. The bow of the violin is made of a back of tough, springy wood, strung with horse hairs. When used the hairs are rubbed with resin to keep them from slipping on the violin strings. The best violins were made in Italy one to two hundred years ago, and fine ones are sometimes sold for $2000 to $3000.

A larger kind of violin is called a viola, and a still larger one a violoncello. The double-bass is a stringed instrument of the same kind, nearly twice as large as the violoncello. All these instruments are, like the violin, played with a bow.

The word violin means a little viol, the name of an instrument used before the violin. The Anglo-Saxon name of the violin was *fythel*, from which comes our word fiddle.

VITRIOL, the name given by old writers to copperas (IRON sulphate), and afterward applied to the sulphates of other metals. Copperas

or green vitriol is made up of iron, SULPHUR, and OXYGEN. It is commonly of a grass-green color, and is largely used in dyeing black, and in making black ink. In old times SULPHURIC ACID was made from it, and was thence called oil of vitriol.

Blue vitriol (COPPER sulphate) is made up of copper, sulphur, and oxygen. It is much used in the arts, especially in dyeing and in the manufacture of green paints; and in medicine it is given as an emetic to cause vomiting, and used as a CAUSTIC.

White vitriol (ZINC sulphate) is made up of zinc, sulphur, and oxygen. It is used in medicine as an emetic, as a gargle for sore throat, and in diseases of the eyes; it is also put into oil paints to make them dry quicker, and is used in printing cotton cloths to fasten the colors.

The word vitriol is from the Middle Latin *vitriolum*, diminutive of *vitreus*, of glass, and vitriol was so called because it sometimes looks like glass.

VULTURE, a bird of prey which lives mostly on carrion or dead animal matter. It is somewhat like the falcon, but has a weaker beak and claws and longer wings, and does not stand upright, but generally stoops a little. The falcon, too, likes living prey the best, but the vulture prefers putrid or spoiled flesh. Vultures fly very high, and their eyes are so strong that they can see great distances. If the body of an animal should be left anywhere, they are sure to see it, and they fly down to it in such haste that they often tumble over and over each other. They soon pick the body clean, leaving nothing but the bones; and they are thus very useful in hot countries, clearing away all the animal matter which, if left to decay, might make disease. They are cowardly and filthy birds, and always have a bad smell about them. Their flesh is not fit for food.

The **Lammergeyer,** sometimes called the bearded griffon and the golden vulture, lives in the highest mountains of Europe, Asia, and Africa, and builds its nest among the rocks in the wildest places. It is the largest bird of prey of the Old World, being sometimes nearly as long as a man. It is very strong, and will kill calves, sheep, deer, chamois, and other small quadrupeds. One has been known, too, to attack children. It is said that the lammergeyer will watch deer and chamois on the mountains until it sees one near the edge of a precipice, and will then fly against it suddenly and throw it over.

The **Condor** is the largest vulture of the New World. It is found chiefly on the western side of the Andes, in Bolivia, Peru, and Chili. It passes the night on the highest peaks of the mountains, and at sunrise spreads its wings and flies off in search of prey. When up among the clouds it can see everything going on in the plain below, and when any prey comes in sight it folds its wings and drops down with great speed. The condor is about four feet long, has bluish-black feathers on the body, with a white downy collar round the base of the neck, and a bare head and neck. It is very strong, but never attacks living animals unless they are worn out with sickness or old age. Condors watch the caravans cross the plains of South America, and when a poor horse or mule falls down with fatigue they attack it and often begin to eat it before it is dead. Worn-out or sick travellers have sometimes been torn to pieces by them. When the condor is gorged with food, it becomes so heavy and sleepy that it cannot fly. The Indians then hunt them on horseback, lasso them, and beat them to death with clubs.

The **Turkey Buzzard** is a kind of vulture found in the United States and in Canada. It is about two

and a half feet long, and is generally brownish-black with a bright red head and neck. It is very plentiful in the Southern States, where it may often be seen in flocks of twenty or thirty. It loves to roost in swamps or tall dead trees, flying out in the daytime in search of dead animals for food. Sometimes it will kill small animals, and even large ones in fields when they are sick and weak. Turkey buzzards often come into the streets in cities and towns in the South, and eat any dead food or animal filth they can find.

The **Carrion Crow**, or black vulture, is found in the Southern States, and in Central and South America. It is about two feet long, is shiny black, and looks somewhat like a crow, though it is not a crow, but a vulture. It may often be seen in company with turkey buzzards, and helps them to clear up the carrion from fields and streets. In South America thousands of them sit during the day on the roofs of houses in cities asleep in the hot sun with their heads under their wings.

The vulture belongs to the order *raptores*, or BIRDS of prey.

The word vulture is from the Latin *vultur*, vulture, from *vellere*, to pluck, and therefore means a "plucker." Condor is Spanish, and is from *cuntur*, the Peruvian name of the bird.

W

WALNUT, the common name of several kinds of nut-bearing trees, of the same family with the hickory. The fruit commonly called walnut in the United States is properly a HICKORY nut. The true walnuts which grow wild in this country are the white walnut or BUTTERNUT and the black walnut.

The **Black Walnut** grows almost all over the United States, but is more plentiful in the West than in the East. It is a very large, fine-looking tree, and its wood is hard, fine-grained, and lasting. When first cut it is purplish-brown, but it grows dark-brown with age. It takes a fine polish, and is much used for furniture and cabinet work, gun-stocks, etc. The fruit is about as large as that of the butternut, and has a very hard ridgy shell, which is black when ripe. The kernel is rich and oily, but soon spoils.

The **European Walnut,** called also English walnut and Madeira nut in this country, grows in Asia and nearly all over Europe. Its wood is not so handsome as that of the black walnut, but is much used for cabinet work, especially in France. In this country this wood is often called French walnut. The nuts are larger than our hickory nuts, and have a smooth, thin shell. Most of those brought to the United States come from Naples, Sicily, and Bordeaux. In countries where the tree abounds the nuts are pressed for their oil, which is eaten like olive oil. A coarser kind of oil, made by a second pressing, is much used by artists and for making the best kind of printers' ink. Walnut wine is made from the sap of the tree, which is quite sweet.

The word walnut is from the Anglo-Saxon *wealh-hnutu,* German *Wälsche Nuss,* foreign nut, the walnut having grown first in Italy, which the Germans call *Wälschland,* foreign land.

WALRUS, a large sea animal related to the seal family. There are two kinds, the Atlantic and the Pacific walrus. The Atlantic walrus is found on the shores of Hudson's Bay, Davis's Strait, and Greenland, and in the Arctic waters of Eastern Europe and Western Asia. A full grown male is about 12 feet long and weighs 2250 pounds. It is an ungainly stupid beast, covered with coarse yellow-brown hair when young, but almost bare when old, and with an immense head with two long tusks growing downward from the upper jaw. These tusks, sometimes two feet long, aid the animals to land on rocky shores and in clambering over ice, and are also used in digging up shell-fish and the roots of sea plants on which they feed. The walrus is very useful to the Esquimaux. Its flesh feeds him, its oil lights and warms his hut, its sinews make his bird-nets, its skin stretched over a light frame makes his boat, its intestines make his water-proof clothing, and its flippers his shoes, and its tusks furnish ivory for many uses and for trade.

The **Pacific Walrus** is found on the coast of Alaska, on the eastern coast of Asia, and in the Arctic Sea north of Bering Strait. It reaches a greater size and weight even than the Atlantic kind, and has a rougher skin. It was not known until 1648, when the Cossack adventurer Staduchin found its tusks on the Arctic

coast of Eastern Asia; but the Atlantic walrus has been known in history since the year 871, when the Norman explorer Othere brought tusks from the Arctic Sea to King Alfred of England. Ancient writers call the walrus sea-cow, sea-ox, sea-horse, and morse.

The walrus is a MAMMAL of the order *carnivora*, or flesh-eating animals.

The walrus was called by the Anglo-Saxons *horshwæl*, horse whale, probably from the noise made by it, which is somewhat like the neigh of a horse.

WASP. There are two classes of wasps: social wasps, which live together in families or societies in one large nest, sometimes having in it as many as three or four hundred, and solitary wasps, which build small nests of two or three cells, made usually out of mud and plastered against a wall or paling. The nests of the social wasps are built usually on the branches of trees, in the way told about under HORNET; but some kinds dig holes called burrows in the ground or use some hole already dug to build their nests in. In winter almost all the social wasps are killed by the cold, but a few females live in a torpid or numb state until spring and lay eggs for the next summer's colony. They do not use the same nest a second season, but go off separately and each one begins a new nest by making a few cells to lay eggs in. Larvæ, or grubs, are hatched from the eggs; these change into pupæ, which are shut up in the cells until they are ready to come out as wasps (see INSECTS). The first brood are all workers, and as soon as they grow up they build more cells, and the female or queen. as she is called, goes on laying more eggs all summer.

Sand and wood wasps belong to the solitary kinds, which do not live in societies. The females dig out cells in rotten wood or in the ground, in each of which an egg is laid. A living spider or other insect, stung so that it is numb, is next put in and the cell is then closed. When the larva is hatched, it feeds on the insect. Sand wasps have stiff brushes on their legs with which they dig the holes for their cells, and wood wasps have strong jaws with which they burrow into wood.

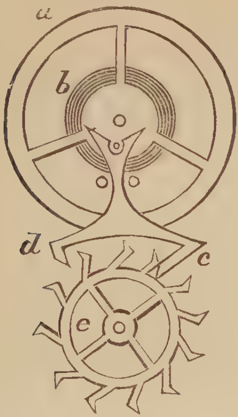
The word wasp is from the Anglo-Saxon *wasp*, from the Latin *vespa*, wasp.

WATCH, a small timepiece to be carried in the pocket. A watch is only a little CLOCK, the train of wheels in each being much the same, but in the watch the mainspring and the balance take the place of the weight and the pendulum in the clock. The mainspring, which is the part that is wound up and which moves the train of wheels, is a coil of narrow ribbon-like steel. When this is wound up tight by turning the watch key, it tries to unwind itself, and thus acts on the train of wheels just as the weight of the clock does: and just as the pendulum of the clock causes the weight to fall slowly, so the balance of the watch causes the spring to unwind slowly and evenly. The balance is made up of the balance wheel *a*, and the hair spring *b*, as shown in the picture. By means of this wheel and spring the teeth, *c* and *d*, of the pallet are made to move backward and forward with a very regular motion, letting out the teeth of the scape wheel *e*, which is moved by the mainspring, one by one, and thus causing it to run down little by little, just as the pendulum acts on the scape wheel of the clock.

The mainspring was first made in the fifteenth century, but it is not known who found it out. Watches are said to have been made in Nuremberg in 1477, and were called from their shape Nuremberg eggs. They were about as large as a goose egg, had to be wound up twice a day, and differed from the true time about an hour in a day; but they

were thought to be one of the wonders of the world, and were sold for a sum which would be equal to about $1500 of our money.

By the beginning of the next century great improvements were made in them, and the second hand was added. The early watches were



Watch Balance.

made in many curious shapes, to resemble pears, skulls, purses, crosses etc. Some were set in the heads of canes, and some in bracelets and other pieces of jewelry. None had glasses over their faces, but open metal-work cases, through which the hands could be seen. Many of them were made to strike the hours. Mary Queen of Scots had several watches, two of which were shaped like skulls, and Queen Elizabeth had twenty-four of different kinds.

Watches could not be made to keep very good time until it was found out, about 1658, how to make the balance wheel, which makes the mainspring unwind evenly and regularly. Since that time many other improvements have been made, so that watches keep time perfectly. Watches are now made which can be wound up without keys, by turning a knob on the stem. The hands are also turned in the same way, so that there is no need of opening the case of the watch except when it needs cleaning.

Chronometer watches are so made that they are not changed by heat or cold, or by any difference of climate in different countries to which they may be taken. They are much used on ships, as they keep much better time than any other kind of watches. Repeating watches are those which strike the hours and parts of hours, by touching a spring, so that the person using one can tell the time in the dark. They are not much used now. Racing watches or horse-timers have a separate second hand which can be started and stopped by touching a spring, so as to time racing horses in going round the track. They are made so carefully that they will mark a small part of a second.

Until within the past twenty-five years watches were made mostly in Switzerland, England, and France, but now a great many are made by machinery in the United States. The principal manufacturers are the American Watch Company of Waltham, Massachusetts, and the National Watch Company of Elgin, Illinois; but there are also several others. In foreign watches each part of the works is made by hand, so that no piece is exactly like the same piece in another watch, but in American watches, where all the parts are cut by machines, the same part will fit in all watches of the same kind. The American watches keep excellent time, and many are now sent to Europe, where they can be sold cheaper than hand-made watches.

The word watch is from the Anglo-Saxon *wæcce*, from *wacan*, to watch, to wake.

WATER. Until about a hundred years ago, water was thought to be an element; but a French chemist named Lavoisier found out in 1773 that it was a compound substance,

that is, a substance formed by the union of other things. We now know that it is made up of two different things, HYDROGEN and OXYGEN. It has in it two measures of hydrogen and one measure of oxygen, but the oxygen is so much heavier than the hydrogen that nine pounds of water contain eight pounds of oxygen and only one pound of hydrogen. Like these gases of which it is made up, pure water has no taste nor smell; and like air it appears to be colorless when in thin layers, but when looked at in large masses, as in the sea and in deep lakes, it is blue (see page 252).

At least three-quarters of the earth's surface is covered with water; the air is full of it in the form of vapor, and all animal and vegetable substances and many mineral substances are largely made up of it. About seven-eighths of the human body is water. But though water is so plentiful, it is never wholly pure. The purest is that which falls as RAIN, but even this is soiled with matter washed out of the air, such as dust and smoke. River and lake waters are purer than spring and well waters, because they are made up of rain water and the water of streams which run only over the earth's surface, while spring and well waters come up through the earth, where they become mixed with solid matter. When water flows through a town or near sewers, it takes up impurities from the drainage of houses, and becomes quite unfit to drink, being sometimes even poison, typhoid fever often being so caused. For this reason most large cities are now supplied with pure water, collected in reservoirs at a distance, brought to town in aqueducts or large iron pipes, and carried into the houses in smaller pipes so that it cannot be spoiled by mixing with the water of the drains. The water of Lake Cochituate, used in Boston, is the purest water carried into any city in the United States, having but little solid matter in it; the Philadelphia and Brooklyn waters have a little more; next in purity is the Croton water; while the water carried into Chicago from Lake Michigan has in it more than twice as much solid matter as the Boston water, and that carried into Albany has more than three times as much.

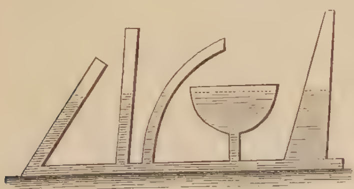
Sea water is a kind of mineral water, because it has a good deal of the mineral salt mixed in it. The salt can easily be taken out of sea water by distillation (see ALCOHOL), and fresh water is often made from salt water in this way on ships at sea. Distilled water is pure water; and rain water is the purest of all natural water, because the turning of the moist vapor of the clouds into rain is a kind of distillation. Every drop of running water on the globe has once been distilled from the ocean as vapor, turned into water again by cool air above, and sent back again in the form of rain, snow, and hail.

Water is called hard when soap does not at once make a lather with it. The waters of springs and rivers may become hard in two ways: by running through rocks which have GYPSUM (CALCIUM sulphate) in them, or through limestone rock or rocks or soil which have chalk (calcium carbonate) in them. Water made hard with gypsum is not changed by boiling, but that made hard by chalk or limestone becomes soft by boiling, and the chalky substance separates from it and forms a white crust, such as is often seen on the insides of tea kettles. Rain water is always soft, and when it runs through a country where the rocks are granite instead of limestone and chalk, it remains soft. When the waters of springs are mixed with a great deal of solid matter from the earth and rocks through which they pass, they are called mineral water.

Water also has various gases dissolved in it. When rain falls it takes

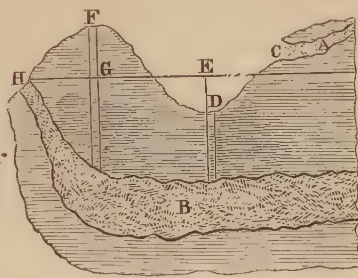
up CARBONIC ACID gas from the air. When put under pressure water will take up a great deal of this gas, as is shown in soda water. The oxygen of the air is also dissolved by water, and it is this which gives to spring water its fresh, pleasant taste. The dissolved oxygen in the waters of seas, lakes, and rivers is necessary for the lives of fishes, which take it out of the water they draw through their gills. This oxygen is not that which helps to make up the water, but comes from the air which is mixed with the water.

When water is at rest in any vessel its surface is always smooth and level. So also if water be put into a number of vessels which are connected with each other so that the water can flow freely through all of them, it will stand at the same level or height in each. It makes no difference whether the vessels be of different shape or size, or what may be their position, the water will rise to the same height in each, as shown in the picture. By under-



Water in Different-Shaped Vessels.

standing this we are able to explain why water rises in springs and artesian WELLS, and why fountains play. The spring is fed by some reservoir within the earth in which the water stands just as high as it rises in the spring. In an artesian well the water is often thrown up above the surface of the earth, because the water in the reservoir which feeds it stands in some part higher than the surface. It makes no difference how far away this may be: if the water can flow freely it will rise nearly as high as its highest part. This will be best understood by the second picture, in which A and B show layers of ROCKS filled with water, and the darker parts above and below them strata through which water cannot flow. The water will flow

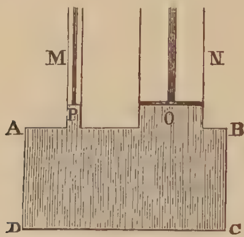


Water in the Earth.

from A, at C, as a spring, and form a brook. The water in B rises to the point H. If a hole be bored down from D to the water in B, the water will rise to E, or as high as the reservoir H, thus making an artesian well. But if a hole be dug at F, the water will rise only to G, or the same height as H and E, and will thus form a common well; and if the water is wanted higher it must be raised with a pump.

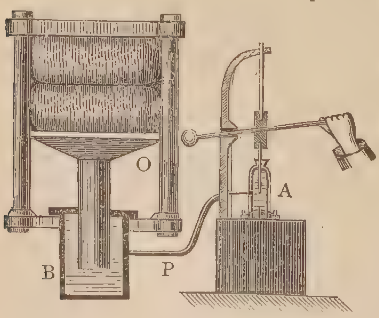
Water in a vessel will press just the same in every direction, that is, sideway, upward, and downward. If a vessel filled with water and closed on all sides have a pipe an inch square set in the top with a piston (see STEAM ENGINE) fitted into it, and a pressure of one pound be put on the piston, every square inch on the inside of the vessel, whether on the top, bottom, or sides, will have an equal pressure on it. If now another larger pipe, fitted with a piston whose surface shall be ten times as large as the smaller one, be also set in the top, as shown in the picture, where A B C D is the vessel, M and N the two pipes in the top, and P and O the pistons, and a weight of one pound be put on the piston P, a pressure of one

pound will be made on every square inch of the piston O, and the weight of one pound on P will bear up a weight of ten pounds on O. The two pistons will thus be evenly



Picture showing Pressure of Water.

balanced; but if more weight be put upon P, more must also be put upon O, or it will not balance, but will be pushed upward. Suppose now that weight enough be put on to P to force it downward one inch. This will push one inch of water down the pipe M, and will force the same amount of water up the pipe N; but as the pipe N is ten times larger than M, the inch of water will be spread over more surface, and the piston O will be forced up only one-tenth part of an inch. The piston P must therefore be pushed



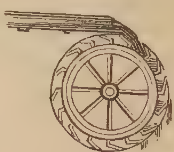
Hydrostatic Press.

down ten inches to raise the piston O up one inch.

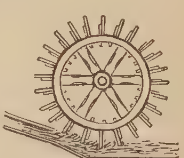
This is a very important principle, and is put to use in a common machine called the hydrostatic or hydraulic press. This can be best understood from the picture. In this A is a force PUMP which forces water through the pipe P into the cistern B. This presses upward the piston O with great force and presses anything placed between the top of the piston and the top of the press. In the picture two cotton bales are being pressed. This kind of press is much used for pressing paper and BOOKS, for making LEAD pipe, and for trying the strength of ropes, chains, and other things.

The word water is from the Anglo-Saxon *wæter*, water.

WATER WHEELS. Water in motion is used for turning machines chiefly by means of wheels. There are three principal kinds of water wheels, all of which may be easily understood by the pictures. In the first is shown the overshot wheel, which is covered with boxes called buckets, which catch the water as it flows or is shot over the top. The buckets on the side of the wheel are thus filled, and the weight of the water makes it turn round. The water stays in the buckets until they get to the bottom of the wheel, when it runs out, and the buckets are filled again when they come under the flowing water. The overshot wheel is used where there is but little water with a considerable fall, as in small mountain brooks.

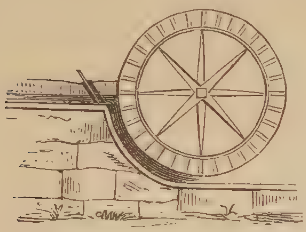

Overshot Wheel.

The **Undershot Wheel,** shown in the second picture, is so called because the water flows or is shot under instead of over its top. This wheel has no buckets, but is fitted with flat boards called floats, and it is turned merely by the force of the stream of water running under it and


Undershot Wheel.

striking on the boards. The undershot wheel is used where there is plenty of water, with but a slight fall, as in common streams.

The **Breast Wheel,** shown in the third picture, is so arranged that the water strikes the wheel at about half



Breast Wheel.

its height, and is kept close to it by the breasting built up under it. The wheel is made much like the undershot wheel, but the boards or floats are set closer together.

Wheels which work horizontally or flat instead of up and down are called turbine wheels. There are many kinds of them, working in different ways.

Water wheel is made up of WATER and the Anglo-Saxon *hwéol*, wheel.

WAX. There are many kinds of wax, some of which are made by insects and some are the growth of trees. The principal insect wax is that made by the honey bee and out of which it builds its honey cells. It was once thought that bees gathered their wax from plants, but it has been shown that they will make wax if they are shut up and fed only on sugar, so it is now known that they make it out of the sweet juices of plants. When the wax of the bee is collected by man, the honey is pressed out of it, and the comb is then boiled in water, melted, strained, and purified in various ways. Beeswax is naturally yellow, but is made white by bleaching. Wax was formerly much used for candles, but stearine candles have nearly taken their place, excepting in Roman Catholic churches, where wax candles are still used. Wax is also used by modellers for making casts and moulds, and wax fruit and flowers. Most of the models of different parts of the human figure, showing diseases etc., in medical museums, are of wax.

Of the vegetable waxes the principal kinds are palm wax, from the United States of Colombia, and myrtle wax, called also bayberry tallow, made in the United States from the scrapings of the berries of the bayberry tree.

The word wax is from the Anglo-Saxon *weax*, wax.

WEAKFISH, a common salt-water fish, caught along the eastern coast of the United States, especially in warm parts. Many are caught around Long Island. The weakfish is shaped like the perch, is one to two feet long, and is greenish brown above and silvery below. Its flesh is good and wholesome for food, but it soon gets soft. It is caught in rather deep water and in the same way as the striped BASS. It bites well at shrimp and crabs. The weakfish is sometimes called wheatfish and squeteague and in the South is misnamed trout and seatrout.

The weakfish is so called because its mouth is so weak that the hook often tears out.

WEASEL. The common weasel of the Northern United States is only about six inches long, with a very slender body, short legs, and short tail with no tuft of hairs on it. A picture of it is given on page 461. Its fur is dark brown above and whitish below. It feeds chiefly on moles, mice, birds, and other small animals, and will often kill chickens. It is very bloodthirsty, and frequently kills more than it can eat, crushing the skull of its prey and sucking its blood. A story is told of a weasel which was carried off by an eagle. When high up in the air, the wea-

sel, after a sharp fight, succeeded in biting through the throat of the eagle, which fell to the ground in a dying state, when the weasel ran away unhurt.

The weasel is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the same family with the ERMINE, SABLE, FERRET, POLECAT, and SKUNK.

The word weasel is from the Anglo-Saxon *wesle*, weasel.

WELL, a fountain or spring of water, which boils or bubbles up from the earth. Mineral springs are called wells in some places. But what we commonly call wells are pits sunk into the ground deep enough to reach water. When these are dug through rock or very hard earth, they are sometimes left unlined, but they are usually walled up with brick or stone, or lined with a large cylinder or tube of earthenware or of iron. Wells are sometimes dug several hundred feet deep before water is reached, and sometimes water is found very near the surface of the ground.

Artesian Wells, so named because first dug at Artois, the ancient Artesium, France, are made by boring a hole in the ground and lining it with a metal tube. Some have been bored more than half a mile deep, though not more than six or eight inches wide. The boring is done by proper tools worked by machinery, and the metal tube is slipped down in pieces as fast as the hole is dug. In some Artesian wells the water comes up to the surface and flows from it in a steady stream, and in others PUMPS have to be used. Water comes up in an artesian well in just the same way that it rises and flows into the upper stories of a house through the pipes from a reservoir. The water that feeds the well has its source in some higher place, from which it is all the time running down into its underground reservoir. The reservoir thus becomes full, and when the well is bored into it from above, the pressure from behind forces the water up the tube and causes it to flow like a spring. There are a great many artesian wells in the United States, the most important ones being in Charleston, Louisville, and St. Louis. The deepest one in the world is in Germany, about twenty-five miles from Berlin. It is nearly four-fifths of a mile (4170 feet) deep.

The **Tube Well,** sometimes called the American well, because it was first used in the United States, is a small iron tube, one or two inches wide, with a hollow steel point. When there is water a little way from the surface of the ground, this can easily be driven down to it. The water flows into the pipe through little holes in the end, and is raised up by a pump fastened to the top of the tube. In the West wells are sometimes bored with large earth augers, an iron pipe being afterward put into the hole thus made.

The word well is from the Anglo-Saxon *well*, *wyll*, or *wylla*, from *weallan*, to boil.

WHALE. Whales are shaped like fishes and are formed to live like fishes in the water. They were once classed among fishes and are still called fishes in common talk, but they are really mammals, for they are warm-blooded and air-breathing animals, bring forth their young alive, and suckle them for some time.

The whale has no neck, and the head makes a third or a fourth of the whole body. The tail is shaped like that of a fish, but is flat sideways instead of up and down, and is often twenty feet wide, or more than three times the height of a man.

The whale has two flippers or fins, one on each side, which are chiefly for balancing the body in the water, the swimming being done mostly with the tail. The skin of the whale is naked and very thick, the inner

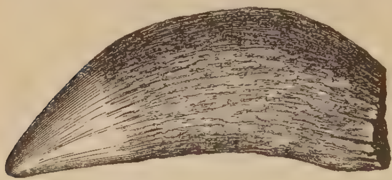
part of it being mixed with fat. This fat is not under the skin, as in other fat animals, but is a part of the skin itself, and is called blubber. It is sometimes two feet thick, and taken altogether is very heavy; but, being lighter than water, helps to keep the whale afloat. It also keeps its blood warm in the cold waters of the Arctic seas, and aids it to bear the great pressure of the water when it goes down deep. Whales can stay under water half an hour, but they usually come to the surface every eight or ten minutes to breathe. They stay up about two minutes, blow eight or nine times, throwing up a stream of water from their nostrils several yards high, and then go down again. There are two principal kinds of whales, the baleen (Latin *balæna*, a whale), or whalebone whale, which has no teeth, and the sperm whale, which has teeth in the lower jaw.

Baleen Whales. There are two kinds of baleen whales, the Greenland or right whale, and the rorqual. The rorqual is called by whalemen razorback and finback, because it has a fin on its back. It is probably the largest of all animals, as it is sometimes more than a hundred feet long, or twice the height of a three-story house. It has less whalebone and blubber than the Greenland whale, and is not often attacked by whalemen. The Greenland whale grows to be sixty to seventy feet long. Instead of teeth the mouth is filled with plates of whalebone, set closely together, and fastened to the roof of the mouth. The edges of these plates form a kind of fringe, as shown in the picture. When the whale feeds it swims along just under the surface of the water with its great mouth open, spouting out through its blow holes the water that goes into its mouth; but all the small fish and little animals that go in with the water are caught in the whalebone fringes and swallowed. The throat is so very small that no fish larger than a herring can be swallowed. The baleen or Greenland whale is often killed by the grampus, a kind of dolphin, which bites it to death.

Mouth of Greenland Whale.
a, Plates of Whalebone; *b*, Bone of Lower Jaw.

The **Sperm Whale** is found in every ocean, and though preferring warmer waters, goes close to the limits of the Arctic regions. It used to abound on the eastern coast of the United States, but is now found chiefly in the North Pacific. It is about as long as the Greenland whale, but it is more dangerous to attack, because it will defend itself with both its teeth and its tail, either biting a boat in two or smashing it in pieces. The teeth, which are pointed like the one in the picture, are in the lower jaw. There are commonly twenty to twenty-five of them of different sizes, some

of them weighing as much as thirty pounds apiece. They are used for ivory, but are not so good as that from elephants' tusks. The sperm whale usually swims in shoals, and



Tooth of Sperm Whale.

sometimes a whole shoal will come to the aid of one which has been harpooned, and will even attack a ship. It has an immense head, and in it is a large hollow called the "case," filled with liquid spermaceti and oil. To get this a hole is cut in the top of the head, and the mixture taken out with buckets. The spermaceti, of which a common sized whale has about ten to twelve barrels, is separated from the oil by boiling. It is a solid white substance, which shines much like MOTHER-OF-PEARL. It is used in making sperm candles, is put into pomatum, and also into "cold cream" used for softening the skin. The sperm whale has a thin blubber, but it yields a fine oil. In the bowels of this whale is often found a kind of waxy substance, which smells like musk. This is AMBERGRIS, which is used in perfumery. The sperm whale can stay under water longer than the Greenland whale. Its throat is also larger, and it can swallow anything as large as a man. Its food is chiefly squids and fish.

The whale is one of the most useful of animals, but it is not so much sought after as it once was, because the oils made from PETROLEUM have mostly taken the place of whale oils, and vulcanized INDIA-RUBBER and steel are much used instead of whalebone.

In 1889 there were 101 vessels employed in whaling, of which 57 were from New Bedford, Massachusetts, 27 from San Francisco, 9 from Provincetown, and 3 from Edgartown, Massachusetts, 2 each from New London and Stonington, Connecticut, and 1 from Boston. The whaling grounds fished were Bering Sea and the Arctic Ocean, the Atlantic, the Okhotsk and Japan Seas, the South Pacific, and the Indian Ocean.

To the Esquimaux and people of Greenland the whale is still of great importance: its oil is used for light, fuel, and food, and even its flesh, which we would think to be rather coarse, is eaten by them; its baleen or whalebone and its other bones are used in making sledges, tents, boats, spears, and harpoons; its sinews make twine and thread, and its thin membranes are used for window-glass.

Whale Fishery. Ships fitted out for the whale fishery are usually not very large, but are built strongly to protect them from the ice, as whales are now found mostly in the Arctic seas about Greenland and Spitzbergen. Each ship carries six or seven whale-boats, sharp at both ends, so that they may be rowed backward or forward, and large enough for a crew of five to seven men. Each boat has in it two HARPOONS and five or six lances. In the bow of the boat is a tub with a long rope coiled up in it. One end of this rope is tied to a harpoon. When a whale is seen from the ship the boats are lowered into the water and have a race to see which shall get to the whale first. As soon as one of them comes near enough, the harpooner, who sits in the bow beside the tub, rises up, takes the harpoon in his right hand and the rope in his left, and casts the harpoon with all his strength into the whale's body, at the same time shouting. "Stern all!" The boat's crew at once back water with their oars, that

is, they row backward, so as to get away from the whale, which, as soon as it feels the harpoon, generally dives down to a great depth, as shown in the picture, dragging the rope after it so fast that water has to be thrown on to the side of the boat to keep it from taking fire. In about twenty minutes it has to come up to blow; the boats row up to it again, and a second harpoon is cast into it. It goes down again, striking the water with its tail, so that great care has to be taken to keep the boats from being crushed. When it comes up again it usually spouts blood, and it is then killed with lances. Sometimes the whale dies at once when lanced, but sometimes it lashes the water into foam and dyes the sea with the blood which it spouts from its nostrils before it dies.

The body of the whale is now towed alongside the ship and fastened to the side with chains. Some of the crew then get on to the whale, having spikes in their boots so that they will not slip off, and cut into the blubber with sharp spades, taking out great pieces, which are hoisted to the deck by hooks and chains. All the blubber is thus cut off, and after the whalebone has been taken from the mouth the rest is turned adrift, and the bears and fishes feed upon it. The blubber is then cut up into smaller pieces and heated in large boilers and strained. The oil is put into barrels, and the scraps that are left after straining are burned to heat other kettles. It is very dirty work, and the ship is made filthy with smoke, soot, and grease.

Harpooning a Whale.

The whale is a MAMMAL of the order *cetacea*, and of a family in which are also the dolphin and the porpoise.

The word whale is from the Anglo-Saxon *hwæl*, whale.

WHALEBONE, a firm, horny substance taken from the upper jaw of the Greenland or right WHALE. There are as many as three hundred plates of whalebone in the mouth of a full-grown whale. It is not properly bone, but is more like the horns of cattle. When softened by boiling, it can be cut up into bristles for brushes, stretchers for umbrellas and parasols, stiffeners for corsets and stays, the handles of whips, canes, and coverings for telescopes and opera glasses. Fine strips of it are also plaited into hats and bonnets and woven into haircloth.

The word whalebone is made up of the Anglo-Saxon *hwæl*, whale, and *ban*, bone.

WHEAT, one of the cereal (see CORN) grains, belonging to the GRASS family. It is not known to grow wild anywhere, but is supposed to have first come from western Asia. It has been cultivated and used for bread from the most ancient times and by almost all nations living in mild climates. It is pictured on the ancient Egyptian monuments, and the Chinese, who say it was given them from heaven, had it nearly three thousand years before Christ. There are a great many different kinds of wheat known, but only about a dozen kinds are grown in the United States. Spring wheat is sown in the spring and cut in the autumn of the same year; winter wheat is sown in the autumn, generally in September, when it sprouts or bursts the seed, then lies all winter, comes up in the next spring and ripens, and is cut about the middle of summer. Some kinds of wheat have white grains and some red grains, and in some the heads are bearded, like that shown in the picture, while in others the heads are bald, or without beards. A kind of wheat is called mummy wheat, because the original seed from which it was grown is said to have been taken from an Egyptian mummy. But there is no proof of this, and all the stories told about the sprouting of grain found in any Egyptian tomb are probably false.


Head of Wheat.

Wheat is the best of all the grains for food, as it has in it much STARCH and GLUTEN, and various mineral or earthy substances which are needed to keep the body healthy. It is used mostly as FLOUR, but a good deal is eaten in the form of crushed or cracked wheat, or wheaten grits. This is simply wheat ground coarsely, and as it has in it all the parts of the grain (some of which are sifted out in making flour), it is very healthful. It should be boiled quite soft and eaten with milk (see MACARONI). Wheat straw is largely used for plaiting for STRAW hats, and it is also valuable to chop up and mix with food for cattle.

The word wheat is from the Anglo-Saxon *hwæte*, the white, and the grain is so named because it is whiter than rye and barley.

WHIPPOORWILL. Whippoorwills are seldom seen during the day. They usually fly in the evening, when the swallows have gone to rest; skimming along near the ground, without making any noise, seeking moths and other soft-bodied insects on which they feed. They have wide, gaping mouths with stiff bristles at the base of the bill, which keep insects from escaping when they are caught. The notes of the whippoorwill are heard for several hours after sunset, and again between daybreak and sunrise. It lays two greenish-white eggs, spotted with blue and light brown. No nest is made, but the eggs are dropped on the ground, usually on fallen leaves.

The whippoorwill belongs to the order *insessores*, or perching BIRDS.

The whippoorwill is so called from its notes, which sound like whip-poor-Will.

WHISKEY, a distilled liquor (see ALCOHOL) made mostly from grain. In the United States whiskey is made chiefly from rye and corn, but it is also made from barley, oats, and rice, and from potatoes and other roots. Whiskey is used for drinking and for making into alcohol, almost

all the alcohol used in the United States being got from it.

The word whiskey is changed from *usquebaugh*, which is from the Celtic *uisgebeatha*, water of life, from *uisge*, water, and *beatha*, life. It is said to have been so called because it was thought that its use in Ireland drove away the leprosy.

WHITEFISH, an important food fish, found in the Great Lakes and in the lakes of British America. It is one of the best of fresh-water fishes, its flesh being white, tender, and juicy. In Lake Superior whitefish of more than twenty pounds are sometimes taken, but the general average is 2 to 10 pounds. They are caught in seines and gill-nets. The whitefish, which is sometimes caught in Otsego Lake, is called there Otsego Bass.

The whitefish gets its name from its color, its scales being silvery white.

WHITING, a fish common on the British coast, much prized for food. It is usually 12 to 18 inches long and of one or two pounds weight, though it grows larger. Its flesh is pearly white, tender, and juicy.

The **Whiting** of the American South Atlantic coast is a different fish, related to the king-fish or hake of Northern waters. It abounds from North Carolina to the Rio Grande in Texas, and is an excellent food fish. In Florida it is called also king-fish, barb, bullhead, whiting, and ground mullet.

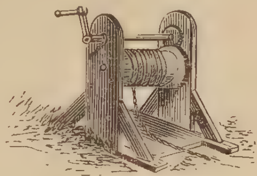
The whiting gets its name from its color.

WILDCAT. See LYNX.

WILLOW, a common tree of the same family with the poplar. Willows are found in almost all countries except Australia. The most common kind in the United States is the shining willow. The white willow is planted in Maryland and Delaware to make CHARCOAL for gunpowder; the wood is also good for fuel. In some countries willow bark is used for tanning leather and for making mats and fishing nets. The osier, used for making baskets, is a kind of willow. The weeping willow, which has long hanging leaves, grew first in Asia and North Africa.

The word willow is from the Anglo-Saxon *welig*, willow.

WINCH, a bent handle or crank for turning a wheel, a churn, a grindstone, the WINDLASS of a well, etc. The name is also sometimes given to



Winch.

the windlass itself, or the axle on which the rope is wound in drawing up buckets from a well or a mine.

The word winch is from the Anglo-Saxon *wince*, a reel or thread.

WIND, moving air. The air is never entirely still, but is always moving somewhere. When any part of the earth's surface becomes more heated by the sun's rays than other parts, the air near it becomes thinner and rises into the higher layers of air until it comes to a layer of the same thickness with itself, when it mixes with it. As it goes up, a current of cooler air rushes in to take its place. Thus two currents of wind are made, one of warm air flowing out and the other of cool air flowing in. Damp air, too, which is lighter than dry air of the same heat, will make a like upward current.

Along the sea-coast there is usually a breeze blowing from the sea during the daytime, and one from the land to the sea during the night. This is because the land is heated by the sun much quicker than the sea; the warm air over the land moves upward and the fresh air from the sea rushes in to take its place. In the night it

is different; the land gives off heat faster than the sea, and thus becomes cooler than it, and its heavier air flows outward over the sea. As the parts of the earth near the equator are much warmer than those north and south of them, the air over them is much lighter, and it is therefore always rising and cooler currents from the cold regions of the north and the south are always moving in to take its place. Hence there are two upper warm currents of air always moving from the equator toward the poles and two lower cool current always moving from the poles toward the equator. If the earth stood still all the time, we should always have a wind blowing from the north in the northern hemisphere, and one blowing from the south in the southern hemisphere. But as the earth is all the while turning round from west to east very fast, each of them is made to slant toward the west, so that the wind from the north becomes a north-east wind, and the one from the south a south-east wind. On some parts of the broad Atlantic and Pacific Oceans these winds, which on account of their value to commerce are called the trade winds, have nothing in their path, and always blow in the same way; but where they blow over the land their course is changed by many things.

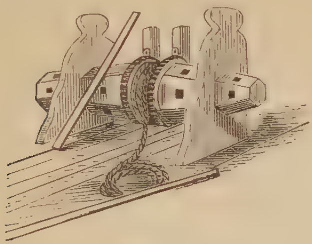
Sailors have more need to know about the winds than men on land, and they have to study them very carefully. They have names for all of them, calling them after the points from which they blow; thus a wind blowing from north to south is called a north wind, and one from west to east a west wind. The winds blowing from the points between the north, the east, the south, and the west winds, are called the north-east, the south-east, the south-west, and the north-west winds. Sailors divide up the winds into thirty-two in all, according to the points of the COMPASS. It is not usual to write out their names in full, but to give only their first letters: thus N. N. E. stand for north-north-east, or the wind which blows half-way between north (N.) and north-east (N. E.); and W. S. W. stand for west-south-west, or the wind half-way between west (W.) and south-west (S. W.). Sailors have also a way of marking the strength of the winds by naming them according to the speed with which they blow. When the wind does not blow at all, it is called a "calm;" when it blows two miles an hour, a "very light breeze;" four miles an hour, a "gentle breeze;" twelve miles an hour, a "fresh wind;" twenty-five miles an hour, a "strong wind;" thirty-five miles an hour, a "high wind;" forty-five miles an hour, a "gale;" sixty miles an hour, a "strong gale;" seventy-five miles an hour, a "violent gale;" ninety miles an hour, a "hurricane;" and one hundred miles an hour, a "violent hurricane." The speed of the wind can be told by instruments which measure its strength, and in many cities an account of the blowing of the wind is kept every day, just as accounts of the heat and cold, as measured by the thermometer, are kept. Such a record of the speed and strength of the wind is kept in Central Park, New York.

In most parts of the world there are winds which are known by special names. Thus, the hot wind which blows across North Africa from the desert is called the "simoon"; the light winds of the Indian Ocean are called "monsoons"; the great storms of the Pacific Ocean, "typhoons"; and the violent storms in the Gulf of Guinea, "tornadoes." The name tornado (from Spanish *tornear*, to turn) is given in the United States to the winds which rush in narrow paths over the country with whirling clouds and rain and hail, tearing to pieces everything in their way. Great damage is often done to trees and

buildings, and men and animals are frequently killed by them.

The word wind is Anglo-Saxon.

WINDLASS, a machine for raising weights. The most common kind is much used in wells for drawing up buckets of water. Such a windlass is made up of an axle around



Windlass

which the rope on which the bucket is hung is wound up, and a handle called the crank or WINCH by which it is turned.

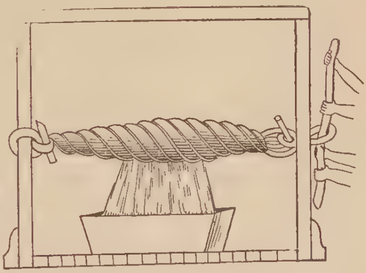
The ship windlass, used on small merchant vessels, instead of a CAPSTAN, is shown in the picture. It is turned round so as to wind up a rope or chain on its barrel by means of bars called hand spikes, which are made to fit into the square holes in it. The windlass is used on ships for raising the anchor, hoisting heavy sails, and pulling up other heavy things. It is fitted with strong pawls or RATCHETS to keep it from turning backward when the hand spikes are moved from one hole to another.

The word windlass is probably from the Dutch *windaas*, windlass, from *winden*, to wind, and *as*, an axis.

WINDMILL, a mill turned by wind. The common windmill is usually a tower with a round top, from which sticks out a shaft having at its end four arms on which canvas is stretched. The wind blows upon the canvas, or sails, and causes them to turn round, and as the shaft is connected by means of cog-wheels, or wheels with teeth, with other wheels inside, the machinery of the mill is made to turn also. The sails will turn best when the wind blows straight against them, and as the wind sometimes comes from one way and sometimes from another, the round top or dome of the tower is so made that it can be turned round so as to bring the sails on the side of the wind. This was formerly done by hand in all windmills, and it is still done in many old ones, but in most new mills the top is so made that the wind itself will turn it. Windmills are much used, especially in places where there are no running streams to turn water wheels, for grinding grain, for raising water to the upper stories of houses, for draining land, and many other purposes.

The word windwill is made up of the Anglo-Saxon words *wind*, wind, and *mylen*, mill.

WINE, the fermented (see BEER) juice of grapes. The kind of wine depends not only on the kind of grape, but on the time when the grapes are picked, and on the way in which the wine is made. For making a lively wine, like champagne, the grapes are picked before they are quite ripe; for a rich-flavored wine, like port, the grapes must be fully ripe; and for sour wines, like



Ancient Egyptian Wine Press.

Rhine wine, the picking is put off as late as possible. The grapes are gathered in baskets in the vineyards, usually by women and children, and emptied into the wine-press. This, which is a large tub with holes in

the bottom, is set over a larger one, called the wine-vat. The grapes are crushed by men who get into the wine-press and tread them down with their naked feet. The juice runs through the holes in the bottom into the vat; and when this is nearly full it is left to ferment or work. This may take a few days or only a few hours, according to the heat of the air. When the juice, which is called the must, begins to ferment, little bubbles of CARBONIC ACID gas rise up through it, caused by the turning of the sugar of the juice into ALCOHOL. The must soon becomes muddy and warm, and froths much on the top, so as nearly to fill the vat, but after a time it settles and gets clear and cool. When cold it is racked—that is, it is drawn off from the vat, through a hole made a few inches above the bottom so as not to stir up the settlings, and put into casks. A second but slighter fermentation now takes place, and the cask is kept open until this stops, when it is closed and is ready for market.

Wines have to be watched very carefully while fermenting, as on this depends their goodness. Some grape juice has much more sugar in it than others; if the fermentation stops before all the sugar is turned into alcohol, the wine is much sweeter than if all the sugar has been fermented. Wines having much sugar in them are called "sweet" wines, and those with but little sugar "dry" wines. Malaga and Tokay are sweet wines, and Madeira, Sherry, and Port are dry wines; but there are often both sweet and dry kinds of the same wine. Wines bottled while the fermentation is still going on will have carbonic acid gas in them. This gives them a brisk taste and causes them to foam when uncorked. Such wines are called "sparkling" wines. "Still" wines are those which do not sparkle.

As the juice of all grapes is colorless, all kinds of wine would be without color, or "white," as they are called, if they were made from juice alone. But when the juice and the skins are fermented together for a time, the wine will have some color. Even the skins of white grapes will give wine a kind of amber color, while those of dark grapes make the rich tints seen in claret and port wines. When wines do not have color enough they are often colored with logwood, burnt sugar, and other things.

The principal wine countries in Europe are France, Spain, Portugal, Germany, Italy, Hungary, Greece. and Turkey. From France comes Champagne, Burgundy, Medoc, Bordeaux, and many other wines. Malaga and Sherry (named from Xeres, near which it is made) are Spanish wines. Port wine comes from Oporto in Portugal. Rhine and Moselle wines come from Germany. Madeira wine is made in the island of Madeira, off the west coast of Africa, and Tokay in Hungary.

Much wine is now made in the United States, chiefly in California, Ohio, New York, Missouri, Illinois, and Pennsylvania. Some American wines are much like those made in Europe, and some are wholly different.

The word wine is from the Anglo-Saxon *win*, from the Latin *vinum*, Greek *oinos*, wine.

WINTERGREEN, the common name of a small evergreen plant which grows wild in the woods almost all over the northern United States and Canada. Its leaves are dark shiny green above and light green beneath, its flowers are white, and it bears little scarlet berries, about as large as whortleberries. They are often called partridge berries, because partridges and other birds live largely on them in winter, and sometimes also checkerberries, squaw-berries, deerberries, and groundberries. Both the leaves and the berries are good to eat. Oil of wintergreen, distilled (see

ALCOHOL) from the leaves, is used for flavoring confectionery and for hiding the bad taste of medicines; but most of that sold as oil of wintergreen is oil of BIRCH.

Wintergreen is so called because its leaves are green all winter.

WIRE, a thread of metal. The ease with which a METAL may be drawn into wire is called its ductility. In ancient times wire was made by hammering out metal into thin sheets, cutting it up into strips, and then hammering and filing the strips into wire. Now the metal is first made into rods by being passed when red-hot between grooved rollers and afterward made into wire by drawing them cold throught holes in a plate of some harder metal, But cast-steel rods for needle wire are prepared with the hammer instead of being rolled. The draw plates are usually made of hardened steel and are full of holes of different sizes. The rods are drawn through these holes, one after another, until they are brought down to the size wanted. Much force is needed to do this, and strong machinery is used for the purpose. Most wire is round, but some is made oval, some square, and some three-sided, for special uses.

Iron wire has a great number of uses; it is made into ropes for ships. cables for bridges, gauze or network, fences, cages, sieves, screens for windows, etc. Steel wire is used for the strings of pianos and harps, and knitting and sewing needles; gold and silver wire for FILIGREE work, and brass wire for pins, hooks and eyes, and many other purposes.

The word wire is from the Anglo-Saxon *wīr*, wire.

WITCH HAZEL. This name is given in England to the witch or wich elm, the leaves of which look much like those of the hazel. The early English settlers in this country gave the name to a shrub or small tree of eastern America, which grows in damp woods from Canada to Louisiana. The leaves and bark contain much tannin; the bark was used by the Indians to cure tumors, and an extract is used in medicine as a wash for sprains and bruises.

The name witch hazel, sometimes written also wych hazel, is probably from the Anglo-Saxon *wican*, to bend, and the shrub is so called from its bending branches and not from any connection with witches, as some think.

WOLF. The wolf looks much like a large shaggy dog, and it has been thought by many that the first dogs sprung from wolves. When taken young the wolf may be tamed, and it shows as much love for its master as the dog does. The wolf is very swift, and hunts deer and other animals in packs. It is sly and stealthy, and often prowls about lonely farms, to catch stray sheep, calves, pigs, or fowls, but is also cowardly and is easily frightened off by the barking of a dog or the sound of a gun. But when pressed by hunger it becomes dangerous, and will attack horses and oxen, and even men. In hard winters packs of hungry wolves come down from the forests of the Alps and other mountains in Europe and commit great ravages. Even in France wolves are still plentiful. From 1882 to 1889 more than 6000 were killed, or above 800 a year. Terrible stories have been told of travellers chased by them in great forests, especially in Russia and Siberia. In one case a man and his wife, riding in a sleigh through the woods, were so hard pressed by wolves that they saved themselves only by throwing out their children, one by one, to be devoured by the hungry beasts. It is said that in Russia more than two hundred human beings are killed by wolves every year, and many thousand cattle and sheep.

In Tartary the wolves are very fierce and attack human beings in preference to animals. In the villages near the Great Wall of China

they often enter houses and carry off children and kill even grown people by seizing them by the throat and strangling them. When news comes that a wolf has been seen near a village hundreds of horsemen go out in search of him. Their weapon is a

Tartar Lassoing a Wolf.

rod furnished with a long cord ending in a slip-knot, like a lasso. The horseman who overtakes the wolf, and this is easy on the great steppes where there are no places too rough for the nimble Tartar horses, catches him around the neck with his lasso, and drags him to the nearest tent. There his mouth is tied up so that he cannot bite and he is cruelly tortured, and finally is skinned alive and turned loose to die. In summer the miserable animal will thus live several days, but in winter he soon freezes to death.

The **Gray Wolf** of North America is usually gray above and yellowish-gray below, but is sometimes nearly white. It is three to four feet long, with a tail about a foot and a half long. Packs of wolves used to follow the buffalo herds on the Western plains, feeding on the sick and straggling ones. They also attack horses, and sometimes men, when very hungry. They were once plentiful in New England and the other Eastern States, but now only a few are found in mountainous and thickly wooded parts.

In 1739 Israel Putnam, who afterward became so well known as General Putnam of the Revolutionary War, began life as a farmer in the town of Pomfret, Connecticut, forty miles east of Hartford. That part of the State was then quite wild, and the wolves were so troublesome that they killed seventy of his sheep in one night. The mischief was all done by one old she-wolf and her cubs, who had lived in the woods near there for several years. The hunters killed the cubs, but the old one was too wary to be caught. She was at last driven by blood-hounds into a den about three miles from Putnam's house. The hunters tried to smoke her out by burning straw and brimstone in the mouth of the cave, but the wolf would not come out, and Putnam, tired of waiting any longer, for it was then ten o'clock at night, took a blazing torch in his hand and went down the hole, which was only high enough for him to crawl on his hands and knees. He had a rope tied round his legs, and told his friends to pull him up when he gave a signal. He crawled along more than thirty feet, or six times a man's length, without seeing anything; but all at once he saw at the end of the cave the glaring eyeballs of the wolf. She gnashed her teeth and gave a sudden growl, and his friends, who heard it, pulled him out so quickly that his shirt was torn to strips and his skin badly cut. He then loaded his gun with buck-shot, and taking it in one hand and a torch in the other, went down again. As soon as he came near the wolf, she growled and made ready to spring on him, but he shot her quickly in the head, and was hauled out again nearly deaf with the noise and choked with the smoke. After the smoke had cleared away, he crawled down a third

time, took the dead wolf by the ears, and the two were pulled out by the people above with much joy.

The Indians catch many gray wolves in traps, and also kill many by surrounding them in a circle which they make smaller, little by little, until they get near enough to shoot them.

The **Prairie Wolf,** which the Mexicans call *coyote*, is smaller than the gray wolf, and is much like the jackal. The true wolf has a howl like that of a dog, but the prairie wolf has only a kind of snapping bark, whence it is sometimes called the barking wolf. It lives it burrows on the great Western plains, is very swift, and hunts in packs.

The wolf is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the dog family.

The word wolf is from the Anglo-Saxon *wulf*, wolf.

WOLVERENE, an American animal, much like the European glutton. The glutton, which lives in the coldest parts of Russia and Siberia, is about as large as a badger and of a deep brown. The wolverene, called also carcajou and skunk bear, is two to three feet long, and is brownish black above with a light band on each side, and a long bushy tail. It is found chiefly in British North America and in the extreme northern parts of the United States. It spends the day in holes and caves and hunts at night, feeding on mice and other small gnawing animals, and grouse and other birds hidden in the snow. It follows hunters and trappers around, stealing the bait from traps and digging up buried provisions. The wolverene is very cunning, and is caught only in carefully concealed traps. Its fur is used for muffs, mats, and sleigh robes. This animal used to be plentiful in Michigan, which is called from it the Wolverene State.

The wolverene is a MAMMAL of the order *carnivora*, or flesh-eating animals, and of the weasel family.

The name wolverene is French-Canadian, and is made from wolf.

WOODCHUCK, a small animal found almost all over the United States and Canada. It is somewhat larger than a rabbit, and is usually blackish-gray on the back and reddish-brown below. It digs deep holes in the ground, with several parts and entrances, and so built that the water cannot run into them. It lies here in a torpid state during the winter and comes out in the early spring. The day it appears is commonly called woodchuck day, because people think they can tell from it what the weather is to be. It is said that if the woodchuck sees its shadow, it goes back into the burrow for six weeks more, and that this means there will be a late spring. The food of the woodchuck is chiefly plants, vegetables, and fruit, and it is often a great pest to the farmer. Woodchucks are very cleanly in their habits, and make pretty pets when tamed. In the Southern States they are sometimes called ground hogs.

The woodchuck is a MAMMAL of the order *rodentia*, or gnawing animals.

The word woodchuck is from the Indian name of this animal, of which one form is *otchock*.

WOODCOCK, a game bird about eleven inches long, with a long bill and a very short tail, and usually yellowish-brown and black shaded. It is a shy, timid bird, and hides itself by day in the thickest woods, from which it comes out at evening to feed. It lives on insects, worms, and grubs, which it seeks in fresh water swamps by thrusting its long bill into the mud. Its nest, built on the ground, is of dried leaves and grass, and it lays four or five yellowish eggs marked with brown. The woodcock is much hunted, as its flesh is greatly prized. As its flight is very swift and irregular, it is a hard bird to shoot.

The woodcock belongs to the order *grallatores*, or wading BIRDS, and to the snipe family.

The word woodcock is from the Anglo-Saxon *wuducocc*, from *wudu*, wood, and *cocc*, cock.

WOODPECKER. Woodpeckers are found all over the world, excepting in Australia. They are active, lively birds, and live chiefly in woods, where they bore into the bark and wood in search of insects and grubs, on which they chiefly feed. The bill is long, sharp, and stout, and the tongue, which is also long and sharp, has on it a kind of gum. The bird holds on to the bark of the tree with its claws, taps the tree with its bill until it finds a hollow place where it thinks a grub is hidden, and then goes to work to dig a hole with its bill, making a loud thrumming noise like a watchman's rattle. When it reaches the grub, if it is a large one it runs its tongue through it and draws it out, but if small it catches it on the gummy end of its tongue. Woodpeckers lay four to six white eggs in nests in the holes of trees. There are several kinds of woodpeckers in the United States, among which the red-headed, the yellow-winged, the hairy, and the black are the most common.

The **Red-headed Woodpecker** is tricolored, red, white, and blue. Its head, neck, and fore breast are crimson, its back, wings, and tail glossy blue-black, and the ends of its wings and under parts of the breast white. It is found throughout the eastern United States and British Provinces and west to the Rocky Mountains and sometimes in California. He is a gay, frolicsome bird, full of tricks, and well known to every schoolboy.

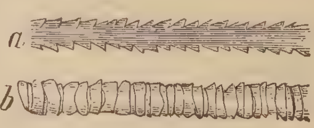
The **Golden-winged Woodpecker** is larger than the red-headed. It is olive-brown on the back with black bars, wings brown above and golden yellow below, breast yellowish-white with black spots, and has a red spot on the back of the head. It is common in eastern North America and is found even on the Pacific coast to Alaska. The golden-winged woodpecker is accused by farmers of spoiling corn, tearing off the husk to get at the milky kernels, and of sticking his long bill into the best apples and pears; he is therefore much hunted, as he is good eating. In some places he is called yellow-hammer and flicker, in Pennsylvania yucker, and by the Southern negroes pi-ut.

The **California Woodpecker,** a bluish-black bird marked with white, common west of the Rocky Mountains, was called by the Spanish Californians *el carpintero*, the carpenter, from his habit of making holes in the bark of trees to store up acorns in. The holes, which are generally made in the white oak, the yellow pine, or the redwood tree, are of different sizes according to the size of each acorn, which is fitted in as nicely and smoothly as if done by a cabinet maker. When the hole is finished the bird brings an acorn without its cup, pushes it in small end first, and then hammers it tightly in with its bill. Some think they save acorns thus to eat in winter, but others say they store them up only for the worms that grow in them.

The woodpecker belongs to the order *scansores*, or climbing BIRDS.

The word woodpecker is made from the Anglo-Saxon *wudu*, wood, and *pycan*, to pick or peck.

WOOL, a covering for the body, something like hair, growing on the skin of the sheep and of some other animals. Hair is usually straight and smooth, but wool is wavy,



Wool Magnified.

and when looked at under the MICROSCOPE is seen to be made up of little saw-like teeth or scales over-

lapping each other and sticking out wherever it bends. These scales are shown in *a*, which is a thread of sheep's wool magnified, and split through the middle so as to show the edges of the scales, and in *d*, which is the same left whole. Though these scales are so small that they cannot be seen with the naked eye (there are about 3000 of them in every inch of some wool), they are of the greatest importance, for without them wool could not be spun into thread to make cloth, and it would not felt (see FELT). When spun, these scales fit into each other and hold fast so that the thread will not untwist; but smooth hair will not keep its twist when spun.

Most wool is got from the sheep, but the ALPACA, and the Cashmere, the Angora, and the Rocky Mountain GOAT also give wool, and the beaver and some other animals have wool under their hair. All sheep's wool is not alike; in some kinds the threads are much longer than in others, and some are fine while others are coarse. Wool is usually six to twelve inches long, but if sheep are not sheared it will grow very much longer, and at the same time coarser. When the fibre is short, wool is called "short staple," and when long, "long staple." Most wool is brought from Australia, South Africa, and South America, but a great deal is grown in Russia, Germany, France, Spain, and Great Britain, and in the United States chiefly in California and other Western States, and in Texas.

Woollen Goods. When wool is taken to the factory to be made into cloth, it is first sorted, so as to put together threads of the same fineness, softness, strength, clearness, color, etc. The different packs are then scoured in lye to get the grease out, and afterward washed in clean water and dried. It is next dyed, unless it is to be made into some kinds of cloth which are not dyed until they are woven. The next process is willying, by which the dust is blown out of it, and it is then picked by hand, to get out burrs, knots, and other large things which the willy machine does not blow out. After picking, the wool is spread over a floor, sprinkled with olive oil, and beaten with sticks. It then goes through the scribbling, carding, and slubbing machines, by which it is further cleaned and is made into a soft weak thread. This thread is then spun by machines into a thread fine and firm enough for weaving (see CLOTH). After the cloth is woven it is beaten with wooden mallets or hammers moved by machinery in a flat trough with soap and water, to get out the oil and dirt, and afterward with clear water. If the wool has not been dyed before, the cloth is now dyed in the piece, washed again, and stretched upon frames in the open air to dry. It next goes through the fulling machine, by which the cloth is pounded or rolled in a thick mixture of soap and water, which causes the fibres of the wool to felt together so that the threads cannot be seen. By this the cloth is made to shrink about a half in width and a fourth in length, and to become much thicker. After fulling the cloth is again scoured and then teaseled, by which the nap is made. This is done by passing the cloth over rollers set full of teasels. Teasels are the burrs or flower heads of the teasel plant, which are covered with stiff sharp prickles. These prickles catch in the wool and pull up enough of the little threads to make a rough surface all over the cloth, which when cut smooth makes the nap. As many as three thousand teasels are sometimes used in dressing one piece of cloth. The nap was formerly cut smooth with hand shears, but it is now done by machines made for the purpose. The finest kinds of cloth are teaseled and sheared several times. The cloth is then cleaned, brushed, and pressed, and folded and packed for

sale. Among the chief kinds of woollen goods are broadcloths (so called because they are fifty-six to sixty inches wide), which include meltons, beavers, pilot cloths, cloakings, and others; narrow cloths (usually about twenty-seven inches wide), which include cassimeres or kerseymeres, doeskins, and tweeds; and upholstery cloths, carriage cloths, flannels, blankets, and some kind of shawls,

Worsted Goods (named from Worstead, in Norfolk, England, where they were first made) differ from woollen goods in being woven from a stronger and harder spun yarn. Yarn for woollen cloth is only slightly twisted, and the fibres are crossed in every way so as to leave them free for felting together when they are fulled; but in yarn for worsted cloth the fibres of the wool are all laid as straight as possible. Among worsted or stuff goods, as they are sometimes called, are merinoes, bombazines, serges, buntings, moreens, damasks, reps, camlets, poplins, cashmeres, Henrietta cloths, and muslin-de-lains. Some are made of all wool, some of wool and cotton, some of wool and silk, and some of wool, silk, and cotton, or wool, silk, and linen.

Shoddy. Cheap cloths and other woollen goods are now made from rag wool, obtained from the ravellings of old garments, tailors' clippings, etc. Wool got from old blankets, carpets, stockings, and flannels is commonly called shoddy, and that from old cloths and tailors' clippings, mungo. Up to 1840 woollen rags were used in France only for fertilizing the soil, but a peasant found out that the ravellings of stockings could be mixed with good wool and spun again, and this began an industry which has grown to be very large and which has made many kinds of woollen goods so cheap that poor people can afford them. The English invented machines for making shoddy, and it is now largely produced in England, France, Germany, and the United States. Cheap kinds of blankets, druggets, carpets, table covers, felt goods, pilot cloths, and other cloths are now made of it mixed with good wool in different proportions.

The word wool is from the Anglo-Saxon *wull*, wool, from Latin *vellus*, a fleece.

WORMS. The bodies of worms are generally long, slender, and round, though some are flat, and they have no skeletons. Worms have no feet, but are usually provided with bristles, hairs, or hooks, which aid them in crawling, and some which live in the water have fins for swimming. Most of them have mouths and eyes, and have also the senses of hearing and of touch.

Worms are divided into two orders: I. Annelida, and II. Entozoa.

I. **Annelida**, so called because they are made up of many rings, are divided into four families:

1. Dorsibranchiata, or back-gilled, which breathe through little gills arranged along their backs. Some of these live in the sea, and both swim and crawl. In hot climates they grow sometimes to be four feet long.

The word dorsibranchiata is from the Latin *dorsum*, back, and *branchia*, gill.

2. Tubicola, or tube-dwellers, which live in shell tubes fastened to rocks, shells, etc., at the bottom of the sea. In some of these the tube is formed of lime which comes out of the animal's own body, but in others it is made of little pieces of shell and stone, and grains of sand which are put into place by the worm and then stuck together with a kind of gum from its mouth.

The word tubicola is from the Latin *tubus*, tube, and *colere*, to dwell.

3. Terricola, or earth-dwellers, so called because they live in the earth. There are many kinds, but they are all much like the common earth-

worm, or angleworm, as it is sometimes called. This has a sharp-pointed head, near the end of which is its mouth. It has no teeth and no eyes. Along the rings of its body are many short, rough bristles, which aid it in creeping or climbing in the ground.

Earthworms live in moist earth, through which they work their way, making long galleries and swallowing the earth as they go; but we are not certain what they do this for. Some writers think they get all their food from the vegetable matter in it, but others believe that they do it only to get the earth out of the way in making their galleries. Earth passes through them just as food does through other animals; the little heaps of fine grained earth often seen on the surface of the ground are earth thrown out by them. These worm-casts, as they are called, sometimes gain so fast as to form a layer of fine soil, and many old pastures owe their richness to them. By throwing up these little heaps, and by boring through and loosening the soil so that the rain can get into it and the fibres of plants can work their way through it, earthworms are of very great use to mankind. They also furnish food for many birds and fishes, and for small mammals and reptiles, such as moles and frogs.

Earthworms seldom come to the surface of the ground, except at night and in wet weather. In times of drought and in cold weather they go deep down into the earth. Their eggs usually have one, but sometimes two young ones in them, which escape out of a kind of VALVE at the end.

The word terricola is from the Latin *terra*, earth, and *colere*, to dwell.

4. Suctoria, or suckers, so called because they have suckers at each end of the body, by fastening which, one at a time, to the ground, and drawing the body up like a loop, they are enabled to move quite rapidly. They can also swim very well by moving the body from side to side. The principal worm of this order is the leech, of which there are many kinds. They live in fresh water, where they feed on earthworms and small water animals, but often fasten themselves to large animals and suck their blood. One kind, called leech, is much used in medicine for drawing blood, which it does without pain. Leeches fasten themselves to the skin by the front sucker, in which is the mouth, pierce it with their three sharp teeth, and suck until they are full, when they let go. The best leeches are brought from the south of Europe.

The word suctoria is from the Latin *sugere*, to suck.

II. **Entozoa**, so called because they are fitted to live within the bodies of other animals. There are many kinds of these, some of which are found in man, some in dogs, horses, and other animals, some in common fowls, and other birds. The worms commonly called tape worms, and hair worms, which look like a long horsehair, belong to this class.

Worms are the lowest class of articulate ANIMALS.

The word worm is from the Anglo-Saxon *wurm* or *wyrm*, from Latin *vermis*, worm. Annelida is from the Latin *annulus*, a ring; entozoa is from the Greek *entos*, within, and *zoon*, animal.

WREN. The common European wren, or kitty wren as it is usually called, is a lively little bird, reddish-brown above and yellowish below. It builds its nest in holes of walls and roofs or between the branches of trees, and lays eight or ten eggs. In France the wren is called *roitelet*, little king, and sometimes *poulette au bon Dieu*, God's little hen. To kill it or to rob its nest is looked upon with horror. It is the same in Scotland, where an old verse thus

calls down curses on him who robs the wren's nest:

> "Malisons, malisons, mair than ten,
> That harry the Ladye of Heaven's hen!"

The **House Wren** of the United States is much like the kitty wren, but is a little larger, more familiar, and a sweeter singer. It loves to build its nest near dwellings, especially in the little boxes and bird-houses often put up for it, and will defend its home with great valor against other birds, and even cats. It lays five or six pale red eggs, and raises two broods each season.

The little wren is a very motherly bird, and has been known to take care of the young of other birds. A pair of robins, which had built their nest and hatched out four little robins in a tall tree near a country house, were found dead on the ground under the tree. The people in the house could see the four little heads of the orphans peeping over the edge of the nest, and could hear them crying for food, but could not help them, the nest was so high. While they were trying to see what could be done, they saw a wren light on the edge of the nest. After staying just long enough to find out what the trouble was, it flew away, but soon came back with food in its mouth for the robins; and it fed them thus every day until the little ones were able to leave the nest.

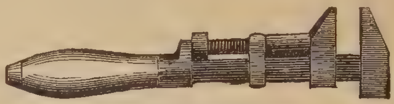
The wren belongs to the order *insessores*, or perching BIRDS.

The word wren comes from the Anglo-Saxon *wrenna*, wren.

WRENCH, an iron tool for turning bolts, nuts, etc. Some wrenches are like a plain bar with a jaw at one

Common Wrench.

end, made to fit a common sized nut (see BOLT), and some, like the one in the picture, are made with a jaw at one end and an opening at the other to turn nuts and bolts with six-sided heads. In the second picture is shown a kind of wrench which may be made larger or smaller, so as to fit any sized nut. This is done by turning round the piece at the



Monkey Wrench.

bottom of the screw, which moves the lower jaw and thus makes the space between the two jaws wider or narrower as wished. This kind of wrench is commonly called a monkey-wrench.

The word wrench is from the Anglo-Saxon *wrence*, wrench.

WRITING. In the article ALPHABET is told that the letters of the English alphabet came to us through the Romans, Greeks, and Phœnicians from the Egyptians. The Egyptians said that Thoth, one of their gods, taught them how to write, but it is probable that the art grew up little by little. Writing was at first only pictures of things; for example, instead of writing out the letters which spell man, tree, house, etc., small pictures of those things were drawn. As it took a good deal of time and trouble to draw a picture of each thing, soon only a part of each was made to stand for the whole thing, or a few rude lines were drawn instead of the full picture; thus, a hand would be understood to mean a man, a straight line drawn up and down a tree, and three straight lines, two up and down and one across the top, a house. In time these rude drawings became symbols—that is, they came to mean something besides the things they were first drawn for: the man's hand was understood to mean strength, the upright line height, etc. Another change came after a while, and some of the symbols or signs grew to mean sounds

or syllables, and two or three of them were joined together to stand for one word. A still greater change came when some of them became letters. The Egyptians used some symbols and some letters in their writing, and never entirely separated the two kinds; but the Phœnicians, when they learned how to write from the Egyptians, gave up the symbols and made the letters into an alphabet, and thus were really the first to write with letters alone. They changed the shape of some of the letters so as to make them more simple, and also changed their names, calling them after such things as they thought they looked like: thus, the letter A (which in the Phœnician alphabet is turned upside down, as &) was thought to look like an ox's head, and so they named it *aleph*, ox, which in Greek became *alpha*.

The Greeks took the Phœnician alphabet, and added a few more letters to it to stand for some sounds in their language which the Phœnicians did not have in theirs. The Romans made their alphabet from the Greek, and from the Romans it came to us with various changes. All European nations now write from the left side of the paper to the right, and all our books are printed in this way; but writing has not always been done so. The Phœnicians wrote from right to left, and the Greeks at first wrote in the same way; then they wrote one line from right to left and the next from left to right, and so on; but as this was not very convenient, they finally changed, and always wrote from left to right. The Chinese and Japanese write in columns, up and down, beginning at the top at the right and going toward the left. The writing of the Chinese and Japanese is wholly different from that of other nations, and did not come from the Phœnicians, but was made by the Chinese. It is made up of many thousand characters, which stand for whole words and for syllables instead of for letters. It is very hard to learn, and very few even of the Chinese themselves know all the characters. The Japanese have made some changes in them. The various things used in writing are told about in the articles BOOK, INK, PAPER, PARCHMENT, PEN, and PENCIL.

The word writing is from the Anglo-Saxon *writan*, to write.

Y

YACHT. The modern yacht, a vessel for pleasure and racing, may be traced back to the Danish *jagt*, a vessel for chasing others, such as enemies or pirates. But the word yacht was not known in England until 1660, when Charles II. was presented by the Dutch with a pleasure boat named the Mary. Such a boat was called in Holland a *jacht*, from *jachten*, to hurry, to hunt, probably because it was used for racing. The first yacht club is said to have been the Cork Harbor Water Club, now the Royal Cork, founded in 1720. This was followed by the Royal Yacht Club in 1812, the Royal Thames in 1823, the Royal Northern in 1824, the Royal Western in 1827, the Royal Eastern in 1836, the Royal Southern in 1843, the Royal Mersey in 1844, and

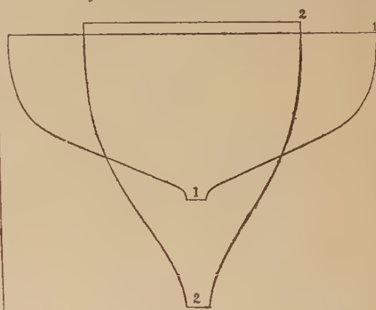


Fig. 1.—1, American Model; 2, English Model.

the Royal Victoria in 1845. Great Britain has now about 50 clubs,

Fig. 2.—English Cutter Thistle.

with nearly 4000 yachts of all kinds and sizes.

The first yacht club in the United States was founded in New York in 1844, and the New York Yacht Club is still the principal yacht club in America.

Yachts have various names according to their build or rig, as schooners, sloops, cutters, yawls, sharpies, cat-boats, catamarans, etc. Schooners and sloops are described under SHIP. In 1851 the schooner yacht America, built by George Steers, who had won a reputation as a builder of fast clipper ships, crossed the Atlantic and won the Queen's Cup in a race around the Isle of Wight, beating the whole English fleet. After this many schooners were built in this country, some of them faster than the America, but of

Fig. 3.—American Sloop Volunteer.

late years sloops have come more into favor, as being more easily handled than schooners. American schooners and sloops are generally built wide and shallow, and are fitted with a centre-board, a movable board that extends below the bottom of a vessel to act as a keel, to prevent the vessel drifting sideways. English yachts, on the contrary, are narrow and deep, with a heavy lead or iron keel, which serves the same purpose as the centre-board. The centre-board yacht skims ver the water, the keel yacht cuts through it. The difference in the two models is shown in Fig. 1.

The **Cutter** is an English type of yacht. Like the sloop it has but one mast, but while the sloop's mast is placed well forward the cutter's mast is set about amidship. Forward of the mast, too, the cutter carries a large foresail or staysail on

a stay from the mast-head to the stem, the jib and flying jib being set on a movable bowsprit which may be run out or in, while the sloop's bowsprit is fixed and immovable. In some respects the cutter rig is handier than the sloop rig. The picture (Fig. 2) is the English cutter Thistle, beaten in New York in 1887 in the race for the Queen's Cup by the American sloop Volunteer (Fig. 3).

The **Yawl** is a sloop-rigged vessel, but with a mainsail so short that the boom leaves room for a small mast, called a jigger-mast, back of the stern-post, which carries another sail, called a jigger, as shown in Fig. 4. It is therefore a cross between the sloop

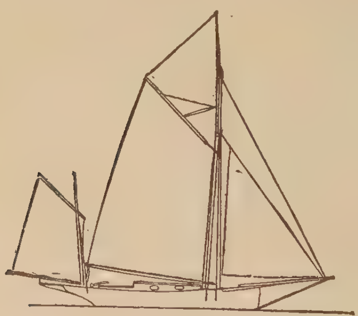


Fig. 4.—Yawl.

and the schooner. This is a very handy rig, as sail can be easily shortened if the wind blows hard, either by taking in the mainsail and sailing under the jib and jigger alone, or taking in the two latter and using the mainsail alone. The yawl has long been used in Europe and is often seen on the Pacific Coast. In the San Francisco Yacht Club it has almost entirely taken the place of the sloop.

The **Sharpie** is a long flat-bottomed sailboat built very sharp in the bow, much used for shooting and fishing in shallow Southern waters. The first sharpies were used by the Fair Haven oystermen in Long Island Sound. They were fitted with a centre-board and leg-o'-mutton or sprit sail, that is, a sail extended by a sprit, as in Fig. 5, and were very useful in shallow

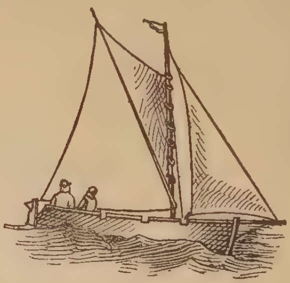


Fig. 5.—Sharpie.

water. They were gradually enlarged and are now built with cabins and decks like other yachts.

The **Cat-Boat** is a boat with but one mast and sail, like a sloop without a jib. The forward part is decked over and the mast is set close to the stem. Cat-boats are generally built wide and shallow and are fitted with a centre-board. They are sometimes large enough to have a

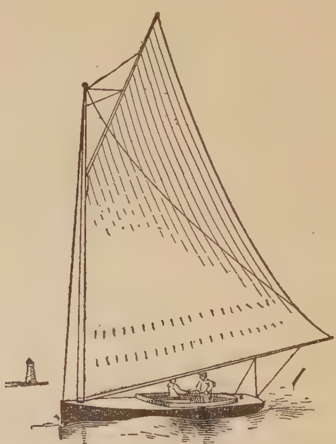


Fig. 6.—Cat-Boat.

cabin forward. The cat-boat is an American boat and is seldom seen in Europe.

The **Catamaran** is a vessel with two hulls, an imitation of the proa of the South Pacific islanders. The proa has a large hull which carries the mast and rigging, and a smaller one on one side intended to give the real hull more stability and to keep it from upsetting. In the catamaran both hulls are of the same size and the space between is decked over. The first catamaran was the Amaryllis, built in 1876 by N. G. Hereshoff, of Bristol, R. I., the builder of many fast vessels. She was sloop-rigged, but others of different rigs have been built since, some with shear masts, that is, with double masts, one in each hull, brought together at the top, as in Fig. 7, and a lateen sail between. Catamarans are very fast, but they are not comfortable and are fit only for racing.

Steam Yachts. In 1883 the American Yacht Club was organized in New York to encourage the building of steam yachts. Since then many fine sea-going steamers have been built, like the Nourmahal, the Alma, and the Atalanta, large enough to cross any ocean, and some very fast smaller vessels, such as the Stiletto, built in 1885 by Hereshoff, which now belongs to the Government, the Now Then, the Say When, and others.

Ice Yachts. These pleasure boats are much used on the Hudson River in winter. They are shaped like a

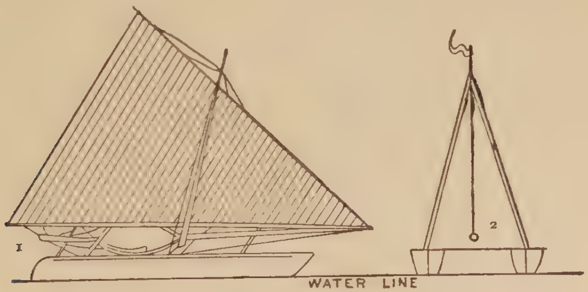


Fig. 7.—Catamaran: 1. Side view. 2. End view.

triangle, and slide over the ice on runners like skates. They are generally cat-rigged or sloop-rigged, but sometimes with shear or double masts and a lateen sail, like one kind of catamaran. Ice yachts will sail very fast, sometimes more than a mile a minute. They are fully described in the Cyclopedia of Games and Sports.

YAK, the wild ox of Thibet, inhabiting the mountains of Central Asia. It is larger than the domestic ox, and is somewhat like the American buffalo in form, though its long shaggy hair hanging nearly to the ground gives it a different appearance. The wild yak, which is generally black, lives near the snow line in the mountains, coming down into the valleys in winter. When tamed, yaks differ in size and color, probably from mixing with common cattle. They are of importance in Thibet, being used in agriculture and as beasts of burden. The yak makes excellent beef and yields rich milk and butter. Its long silky hair is spun into ropes and woven in many fabrics. Yak's tails are used in India as fly brushes, and when dyed and fitted with costly handles as decorations. The Chinese dye them red and wear them in their hats.

The yak is a MAMMAL of the order *ruminantia* or cud-chewing animals.

The word yak is from the Thibetan *gyak*.

YAM, a vegetable much like the sweet potato, but larger, some yams weighing thirty to forty pounds apiece. There are many kinds, all of which grow in hot countries. The roots are coarser and not so good as those of the sweet potato, but are much eaten, either roasted or boiled, in Africa, China, Japan, South America, and the West Indies.

The word yam is from the Spanish *igname*, which is from the African *inhame*, yam.

YEAR. See CALENDAR.

YEAST, the froth which rises on the top of BEER and other liquors when they ferment. When looked at under the MICROSCOPE, yeast is seen to be made up of little cells of plants called yeast-plants, which are a kind of FUNGI. It is yeast which makes drinks ferment and thus turns the sugar in them into ALCOHOL. Sugar will not turn into alcohol of itself; it needs yeast to force it to change. Yeast is put into BEER for this purpose, but not into cider and wine, because the juices of grapes, apples, and other fruits have some GLUTEN in them which becomes yeast and acts on their sugar just as common yeast does. When yeast is put into bread it makes a ferment in it in just the same way as in liquors. It turns the sugar in the dough into alcohol and carbonic acid gas; the alcohol goes off in steam, and the gas swells up the BREAD and thus causes it to rise.

The word yeast is from the Anglo-Saxon *gist*, yeast.

YELLOW BIRD. This bird is sometimes called the American gold-finch and the thistle bird. It is found all over North America, is very hardy, and often stays all winter in the Middle States. The male is bright yellow, with black tail and wings marked with white, and with black on top of the head; the female is yellowish-brown above and darker brown below. Yellow birds are usually seen in flocks, feeding on the seeds of thistles, sunflowers, and other plants. They are beautiful and sprightly little birds, and their song is very pleasing. They are often caught and kept in cages, being easily tamed, and they make as pretty pets as canaries. By hard training they are sometimes taught many pretty tricks. There was once one which would draw water, when it wanted a drink, from a little well in the bottom of its cage. The bird would draw up the chain which was fastened to the bucket by pulling it up in its bill as far as it could reach, then putting his foot on it, would reach lower down and pull up a little more, until at last the bucket would be brought near enough to drink. It drew up its seeds, which were kept in a little wagon, in the same way. Yellow birds build nests in trees or bushes out of lichens, which they stick together with a fluid from their mouths, and lay four to six bluish-white eggs, specked at the larger end with brown. They raise only one brood each season.

The yellow bird belongs to the order *insessores*, or perching BIRDS, and to the finch family.

The yellow bird gets its name from its color.

YELLOWHAMMER. See WOODPECKER.

YELLOWLEGS, a common game-bird of North America. It is about eleven inches long, is ash-color with spots of brownish-black above and white below, and has a greenish-black bill and long yellow legs. It is found on the Atlantic coast from Maine to Florida in summer and migrates to Mexico and Central America in winter. It is usually seen in small flocks in swamps and on the sea-shore, wading in search of shrimps, worms, and similar food. Its nest is made in the grass on the edges of rivers and ponds. It gets very fat in autumn and is good eating.

The yellowlegs belongs to the order *grallatores* or wading birds.

YEW, an evergreen tree, common in Central and Southern Europe and in Asia. It is a slow growing and long lived tree, with a thick irregular trunk and dark thick foliage. It seldom grows more than 30 feet high, though some are over fifty feet. Its wood is heavy, fine-grained, very lasting, and elastic. Before the time of fire-arms, it was much used for making bows, it being considered in England the best wood for that purpose. It is now used in cabinet work, both solid and as veneering, and for making axletrees and other things where great strength is needed. In England it is often seen growing in graveyards, because, it is said, the ancient Celtic priests looked upon it as an emblem of immortality on account of its long life. In the churchyard at Darley, in Derbyshire, is one said to be 1300 years old. In England, too, it is often clipped into strange shapes.

There are several kinds of yew in America. The short-leaved yew of the Pacific coast, which grows 50 to 70 feet high, has a hard fine-grained wood valuable for fence posts. The Indians made bows, paddles, and other things of it.

The word yew is from the Anglo-Saxon *iw*, yew.

YUCCA. There are about twenty kinds of this useful plant or tree, natives of the United States, Mexico, and Central America. The common yucca, which grows abundantly in New Mexico, Arizona, and Southern California, is 2 to 18 feet high, and further southward becomes a tall tree with a diameter of 8 to 20 inches. The Indians and Mexicans eat its fruit, both fresh and dried. They also cut the stems into slices, beat them to pulp, and mix it with water in washing instead of soap, for which it answers finely. The leaves, which are two feet long, are are very fibrous. The Indians separate the fibres from the woody part by beating them with a wooden mallet and soaking in water, and make from them horse blankets, ropes, twine, nets, hats, hair brushes, shoes, and mattresses. Some kinds of yucca are beautiful flowering plants, others furnish seeds which are eaten raw and roasted, or made into flour, others are eaten like asparagus, and still others make excellent paper.

The word yucca, which is Spanish. is from the Indian name of the plant,

Z

ZEBRA. This animal is shaped more like the ass than like the horse, and has a tail with a bushy tuft at the end and a mane that stands straight up. Its chief beauty is its skin, which is usually of a creamy-yellow color striped all over with rich velvety black bands. The zebra is found in South Africa, especially in the mountainous parts near the Cape of Good Hope. It is very strong, swift, and sure-footed, and can bound up hills and over rocks as nimbly as a goat. If it could be tamed, it would be a valuable animal, but it is hard to break its wild spirit. A few have been used in South Africa to carry burdens, and several have been trained in menageries. The Hottentots often hunt zebras, as they think their flesh a great delicacy, but white people find it rather coarse. White hunters try to catch them alive to sell them to menageries for exhibition. Zebras commonly live in herds, and when feeding on the hillsides one of their number always keeps watch as a sentinel. When attacked by men or other animals they form in a circle with their heads inward, and defend themselves by kicking.

The zebra is a MAMMAL of the order *pachydermata*, or thick-skinned animals, and of the horse family.

The word zebra is African.

ZEBU, an animal of the ox family, marked by a large fatty hump on the shoulders. Apart from this it looks much like the common ox or cow, though the horns are short and sometimes entirely absent, and the ears are long and hang downward. The male is brown with coarse hair; the female mouse-gray with fine hair. The zebu is found chiefly in India and the Indian islands, but also in China, Arabia, Persia, and the east part of Africa. It is held sacred by the Hindus, who consider it a sin to kill them, though they make them work. They ride them, too, like a horse. and it is said that a zebu will carry a man at the rate of six miles an hour for fifteen hours. White bulls are held particularly sacred, and when dedicated to Siva by having his image branded on them, are kept from all labor. They are allowed to go wherever they choose, and may be seen in Eastern bazaars helping themselves to dainties from the stalls. The zebu has been tamed from the earliest times, all the ancient pictures of cattle in the caves at Elephanta being of the humped kind.

The zebu is a MAMMAL of the order *ruminantia*, or cud-chewing animals.

The word zebu is of unknown origin.

ZINC, a METAL, and one of the principal ELEMENTS. It is not found as a metal, but in ores united with some of the other elements, such as oxygen or SULPHUR. The chief ore is a compound of zinc and sulphur (zinc sulphide) called blende. When pure, zinc is a bluish-white metal, hard and brittle at common heat, but when heated hot may be hammered or rolled out into thin sheets. It discolors and rusts a little in moist air, but the thin film or crust of rust sticks closely to it and keeps the part under it from further change. On this account zinc is very useful for making bath tubs, water spouts, pipes, tanks, roof covers,

and many other things likely to be wet. Sheet iron, iron wire, and iron cables are also often covered with a coat of it to keep them from rusting. Iron thus coated is commonly called "galvanized iron," but this is wrong, as the zinc is put on, not by galvanism (see ELECTRICITY), but in the same way that tin is put on iron plates in making sheet TIN. Zinc forms several valuable ALLOYS, among which the most useful are BRASS, BRONZE, and German silver.

Zinc is found in the United States, in Missouri, Pennsylvania, New Jersey, Kansas, Wisconsin, Virginia, Tennessee, and Iowa.

Among the compounds of zinc are the paint called zinc white (zinc oxide), made up of zinc and OXYGEN; and white vitriol (zinc sulphate), made up of zinc, sulphur, and oxygen, which is used in medicine and the arts.

The word zinc is *zink* in German Swedish, and Danish.

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